United States Department of State

Bureau of Political-Military Affairs
Directorate of Defense Trade Controls

Washington, D.C. 20520-0112

In Reply Refer to
DTC Case **TA 2721-04 (Reissue)**

Mr. Ronald B. Alexander
Analex Corporation
5904 Richmond Highway, Suite 300
Alexandria, VA 22303

YOUR LETTER DATED: October 12, 2004
AGREEMENT FOR: Technical Assistance
FOREIGN LICENSEE: Alcatel Space – France
COMMODITY: Technical Data and Defense Services for Mission Qualification and Pre-Launch Services for the CALIPSO Satellite

Dear Applicant:

The Department of State approves the request as identified subject to the limitations, provisos or other requirements stated below. The agreement may not enter into force until these requirements have been satisfied. Any request for extension must be submitted to the Department for approval no later than 60 days prior to the authorized expiration date.

Sincerely yours,

for Peter J. Berry
Director, Office of Defense
Trade Controls Licensing

LIMITATIONS, PROVISOS AND OTHER REQUIREMENTS:

1. This authorization **expires December 31, 2008.**

2. Sublicensing is not authorized under this agreement. If sublicensing is contemplated, the applicant must submit an amendment request describing the sublicensing activity.

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3. The applicant may not export hardware, software, technical data or defense services against this agreement until all parties have executed the agreement. In accordance with 22 CFR 124.4(a), submit one copy of the signed agreement, revised as may be required herein, to this office no later than 30 days after it enters into force. The applicant must inform DTC within 60 days if deciding not to execute this approved agreement.

4. If the agreement is not executed within one year of this approval, a written report as to the status of the agreement must be submitted to this office on an annual basis until the requirements of 22 CFR 124.4 or 22 CFR 124.5 have been satisfied.

5. Shipment of hardware against this agreement under the provisions of 22 CFR 123.16(b)(1) or by separate license (i.e., DSP-5, DSP-73) is not authorized. Hardware shipment may take place only after the Department of State approves an amendment to the agreement.

6. To assist the U.S. Government in processing future applications, Analex Corporation is requested to NOT bind their application packages.

7. Applicant must provide NASA HQ, Export Control and Interagency Liaison Division/John Hall, 300 E. Street, SW, Washington, DC 20546, with a copy of the State-approved license and signed TAA.

8. Applicant is authorized to transfer NASA-controlled technical data and defense services as described in the TAA and Annexes B & C and Exhibit 3. Transfer of other NASA non-public domain technical data in support of this TAA requires prior NASA approval. Contact John Hall for approval (phone: 202-358-2070, fax: 202-358-4080, email: John.F.Hall@nasa.gov).

Applicant must brief applicable NASA project managers/staff on the scope and limitations of access allowed by this license.

9. If a Technology Transfer Control Plan (TTCP) requirement is imposed, applicant must provide a copy of the approved TTCP to NASA HQ, Code ID/John Hall, 300 E. Street, SW, Washington, DC 20546.

10. To the extent that DoD participation in any audit or meeting performed by the U.S. Government is reimbursable to the DoD, NASA-provided funds shall not be used for such reimbursement.

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11. The applicant's independent analyses products or test data released MUST be limited to results only. The applicant may reference specifications and requirements (S&R) that MUST be met to ensure the safe integration of the spacecraft and launch vehicle. The applicant may point out to the foreign consignee the exact S&R that are NOT being met. However, the applicant MUST NOT augment or suggest changes to the foreign consignee's processes that optimize, enhance, improve or increase the capabilities of the consignee or correct a specific deficiency. Design or technical analysis tools or methods of assessment (models, algorithms, databases, or software) which are NOT in the public domain MUST NOT be offered or released.

12. Technical meetings and activities between the applicant and the foreign consignee may be attended and observed by the U.S. launch service provider. However, the U.S. launch service provider may NOT actively participate in those technical activities since they are NOT a signatory to the applicant's TAA, unless the launch provider obtains its own license or is added as a signatory to this agreement in an amendment. The applicant MUST inform the U.S. launch service provider of this restriction.

EXHIBIT 1

Technical Assistance Agreement (TAA)

Technical Assistance Agreement for CALIPSO

This agreement is entered into between Analex Corporation (Analex), an entity incorporated in the state of Delaware with offices at 5904 Richmond Highway, Suite 300, Alexandria, VA 22303 and Alcatel Space company with offices located at 12, rue de la Baume 75008 Paris, France, (http://www.alcatel.com)., and is effective upon the date of the last party to sign the agreement.

WHEREAS Analex will provide technical assessment and mission qualification pre-launch services for the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite to Alcatel under its Expendable Launch Vehicle Integrated Support (ELVIS) contract with NASA; and

WHEREAS NASA's Langley Research Center in Hampton VA leads and manages CALIPSO for the NASA Earth System Science Pathfinder (ESSP) program and collaborates with the French space agency (CNES), Ball Aerospace and Technologies Corporation (BATC), Hampton University, Alcatel Space in Paris, and the Institute Pierre Simon Laplace (IPSL) in Paris. CALIPSO, scheduled for launch in April 2005, is designed to operate for three years.

WHEREAS Alcatel Space is responsible to design, manufacture, produce, and assemble the CALIPSO spacecraft bus, under contract to CNES;

NOW THEREFORE, the parties desire to enter into the Technical Assistance Agreement as follows:

1. The National Aeronautics and Space Administration (NASA) has negotiated a formal Memorandum of Understanding or MOU (ANNEX A) with CNES that has the former agree to use its launch services contract to launch the French-built CALIPSO to support its operations once on orbit, checked out, and functioning; and to share the Earth science data that CALIPSO will produce. The MOU calls for the signatories' centers and contractors to produce a detailed breakout of the tasks and responsibilities of the parties called a CALIPSO Project Plan (ANNEX B) that shall be empowered by the MOU and have the force of an international cooperation agreement concluded by NASA and CNES on its behalf.

CNES has contracted with Alcatel Space, the builder of the PROTEUS spacecraft bus, for the CALIPSO spacecraft bus. CNES contracted with European Aeronautic Defense and Space (EADS) Sodern for the Imaging Infrared Radiometer (IIR.) CNES, with help from Alcatel Space will integrate the payload and the spacecraft and CNES will operate the spacecraft once it is on orbit. (Note: Raytheon is also assisting CNES with tasks under a separate agreement, TA 2527-02.) BATC will develop the laser detection and ranging (LIDAR) and the Wide-Field Camera (WFC) for CNES to integrate. Hampton University and IPSL will provide Co-Principal Investigators (Co-PIs) to conduct experiments with CALIPSO as described in Exhibit 2.

NASA has contracted with Analex to perform a safety and mission assurance oversight role, launch site support engineering role, a launch operations management role, a mission integration coordination role, a communication and telemetry support role, to provide technical services to the NASA/Analex Launch Engineering Team (LET), provide on-site technical, security, and

administrative support and assist in the technical preparation of the spacecraft at Vandenberg AFB, California, provide mission analysis of the following analytical areas: Loads and Structural Dynamics, Dynamic Environments, Stress, Flight Design, Flight Software, Controls and Stability, Thermal/Thermodynamics, Electromagnetic Compatibility & CFD/Aerodynamics, and perform engineering and analyses for the NASA Program, which necessitates this agreement.

This Technical Assistance Agreement (TAA) is required so that Analex can carry out its responsibilities. Analex personnel will perform the work on site at Vandenberg AFB, California to get the Delta launch vehicle and CALIPSO payload integrated and ready for launch, and other tasks required of it by the CALIPSO Project Plan and the ELVIS contract Statement of Work or SOW (ANNEX C).

Analex must be able to work closely with the U.S. launch services provider, The Boeing Company (Boeing), and with the French payload contractor, CNES, and with the main CNES spacecraft bus contractor Alcatel Space. Analex' work with Boeing, CNES and Alcatel Space may involve any or all of the services, tasks, and technical data described in the CALIPSO Project Plan and the ELVIS SOW. That is, Analex must be able to help integrate the spacecraft payload with the launch vehicle, assure its interfaces with ground systems are optimal, solve engineering and technical problems on the spot, and perform other, related work with Alcatel Space at Vandenberg.

This TAA does not include Boeing, BATC, or Analex Corporation's subcontractors aiSolutions Corporation and Science Applications International Corporation (SAIC). BATC and Boeing have their own TAAs with CNES, TA 0293-02, and other U.S. entities will submit their own license or TAA applications as these prove to be necessary.

2. It is understood that this Technical Assistance Agreement is entered into as required under U.S. Government Regulations and as such, it is an independent agreement between the parties, the terms of which will prevail, notwithstanding any conflict or inconsistency that may be contained in other arrangements between the parties on the subject matter.

3. The parties agree to comply with all applicable sections of the International Traffic in Arms Regulations (ITAR) of the U.S. Department of State and that more particularly in accordance with such regulations the following conditions apply to this agreement:

I. ITAR Section 124.7

(1) Analex will work with the French CALIPSO payload satellite partner, Alcatel Space. Analex' work with Alcatel Space may involve any or all of the services, tasks, and technical data described in the CALIPSO Project Plan and the ELVIS SOW. That is, Analex must be able to help integrate the spacecraft payload with the launch vehicle, assure its interfaces with ground systems are optimal, solve engineering and technical problems on the spot, and perform other, related work with Alcatel Space at Vandenberg. No hardware will be manufactured or exported under this agreement.

(2) NASA has procured and will provide launch services on a Boeing Delta II heavy-lift vehicle and pre-launch engineering support. This includes providing NASA engineering support for Alcatel Space spacecraft design and development (including mission design, associated Interface Control Documents or ICDs, payload processing and integration), identifying and implementing mission unique requirements, providing early orbit engineering support, and providing NASA oversight of the CALIPSO program as needed to satisfy requirements of the ICD. NASA and its contractors will jointly develop and verify ICDs on the interface between CALIPSO and the launch vehicle. Analex will support NASA with payload integration and testing (I&T) services on the launcher.

Meetings and telephone conversations/conferences will take place as necessary to maintain control of respective areas of responsibility, on an as required basis. As a general rule, no contractors will be in attendance without prior approval, on an as needed basis.

Working Groups will be conducted in accordance with the ELVIS contract.

Reviews and Launch Site Activities will be on an as required basis, and parties will be invited to attend as appropriate.
Technical interface will include ICDs, Contamination control plans, Launch Site Test Plan, Launch Site Procedures, etc., as per the CALIPSO Project Plan and the list of documents at EXHIBIT 3. No hardware will be shipped under this agreement. If it becomes necessary for Analex to ship hardware to Alcatel Space, a separate export license will be applied for.

(3) This TAA is to enter into effect on the date of the final signature and is to remain in effect until December 31, 2008.

(4) Technical data will be shared with Alcatel Space in France and with their employees in the U.S., mostly if not exclusively at Vandenberg Air Force Base, California and in its vicinity. Analex will deliver on-site support services to Alcatel Space French personnel at Vandenberg or in its vicinity.

II. ITAR Section 124.8

(1) This agreement shall not enter into force, and shall not be amended or extended without the prior written approval of the Department of State of the U.S. Government.

(2) This agreement is subject to all United States laws and regulations relating to exports and to all administrative acts of the U.S. Government pursuant to such laws and regulations.

(3) The parties to this agreement agree that the obligations contained in this agreement shall not affect the performance of any obligations created by prior contracts or subcontracts which the parties may have individually or collectively with the U.S. Government.

(4) No liability will be incurred by or attributed to the U.S. Government in connection with any possible infringement of privately owned patent or proprietary rights, either domestic or foreign, by reason of the U.S. Government's approval of this agreement.

(5) The technical data or defense service exported from the United States in furtherance of this agreement and any defense article which may be produced or manufactured from such technical data or defense service may not be transferred to a person in a third country or to a national of a third country except as specifically authorized in this agreement unless prior written approval of the Department of State has been obtained.

(6) All provisions in this agreement which refer to the United States Government and the Department of State will remain binding on the parties after the termination of the agreement.

ADDITIONAL TERMS

1. This authorization expires December 31, 2008.

2. Sub-licensing is not authorized.

3. No shipments of hardware, software, technical data, or defense services may take place until such time as the agreement has been executed by all parties. In accordance with 22 CFR 124.4(a), a copy of the signed agreement, revised as may be required by the Department of State, shall be submitted to the Office of Defense Trade Controls within 30 days from the date that it is signed. If a decision is made not to execute the approved agreement, the applicant shall so inform the Office of Defense Trade Controls within 60 days.

4. If the agreement is not executed within one year of the date of this approval, a written report as to the status of the agreement shall be submitted to the Office of Defense Trade Controls on an annual basis until the requirements of 22 CFR 124.4 or 22 CFR 124.5 have been satisfied.

5. Shipment of hardware against this agreement under the provisions of 22 CFR 123.16(b)(l) or by separate license (i.e., DSP-5) is not authorized'. Hardware shipment may take place only after the Department of State approves an amendment to the agreement.

6. The applicant shall not release detailed design data or concepts, design methodology, or manufacturing know-how for the Delta II launch vehicle, components, and ground support equipment. Technical procedures (to include the launch vehicle countdown procedure) that are launch vehicle specific are <u>not</u> authorized for release.

7. The applicant shall not provide any technical assistance to the consignee(s) who might assist the consignee(s) in the design, development; or enhancement of contemplated or existing space systems, launch facilities, or launch processes/operations.

8. All anomaly/problem resolution shall be accomplished strictly by the responsible parties. Collaborative failure analysis with foreign parties is not authorized. Anomaly/non-conformance/failure reports shall be limited to functional block diagrams, top-level descriptions, and drawings/schematics that do not reveal detailed design. Data shall not contain systems engineering processes, techniques, or methodologies.

9. Information on U.S. Government (USG) systems, operations, limitations, or capabilities that is not already in the public domain shall not be offered, discussed, or released.

10. Launch failure analysis or investigation is not authorized under this license. In case of a launch failure, discussions or transfer of any technical data shall be the subject of a separate license submitted for Department of State approval.

11. There shall be no unmonitored or unescorted access to the launch vehicle or any controlled equipment or technical data related to the launch, unless otherwise authorized by a license. Whenever foreign nationals are present, monitoring shall be on a 24-hour basis by U.S. participants throughout launch preparations, satellite mating/demating, test and checkout, launch, and debris recovery.

12. The applicant shall maintain a library of released technical data subject to USG inspection and audit. The cost of DOD participation in any audit performed by the USG is reimbursable to the DOD.

14. Applicant shall provide NASA HQ, Code ID/John F. Hall, Esq., 300 E. Street, SW, Washington, D.C. 20546, with a copy of this Department of State approval memo (license), and signed Technical Assistance Agreement.

15. Applicant understands that NASA-controlled technical data listed in this TAA will be approved for transfer. Transfer of other NASA non-public-domain technical data in support of this TAA requires NASA approval. Applicant will contact Mr. John F. Hall, Esq. for approval (phone: 202-358-2070, fax: 202-358-4080, e-mail: john.f.hall@nasa.gov).

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed effective as of the day and year above provided.

Ronald B. Alexander

Senior Vice President, Chief Financial Officer and Corporate Secretary

M. Joël CHENET

Senior Vice-President Observation & Sciences

ANNEX A

CALIPSO Memorandum of Understanding (MOU)

Between NASA and CNES

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OF THE UNITED STATES

AND

THE CENTRE NATIONAL D'ETUDES SPATIALES

OF FRANCE

FOR COOPERATION IN

THE CALIPSO MISSION

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Preamble

The National Aeronautics and Space Administration of the United States (hereinafter referred to as NASA), represented by its Administrator, and

The Centre National d'Etudes Spatiales of France (hereinafter referred to as CNES), as established under the provisions of the Law 61-1382 dated December 19, 1961, setting up a national center for space research, represented by its President,

as the Parties to this Memorandum of Understanding (MOU) (hereinafter the Parties),

CONSIDERING their cooperative effort that led to the successful TOPEX/Poseidon mission launched by an Ariane launch vehicle on August 10, 1992, and their agreement of December 20, 1996, for the Jason-1 program,

RECOGNIZING the need for a mission to collect data to understand better the role of clouds and aerosols in climate, thus improving the ability to predict long term climate change and seasonal to interannual climate variability,

CONSIDERING that such a mission could use light detection and ranging (lidar) technology and applications,

RECALLING the success of the first demonstration of the feasibility of lidar in NASA's Lidar In-Space Technology Experiment (LITE), launched on the STS-64 mission in September 1994,

CONSIDERING their common interest in developing the capacity to use a lidar instrument on a long-term basis to improve the ability to predict long term climate change,

RECALLING that a cloud and aerosol mission was recommended for Phase A study by the CNES science advisory panel (CPS) in March 1998, following the prospective scientific seminar in Arcachon, France,

RECALLING that the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission, including CNES participation, was selected for development in December 1998 by NASA's Earth Science Enterprise through its second Earth System Science Pathfinder (ESSP-2) Announcement of Opportunity (AO), and

RECALLING that in October 1999, the CNES Board of Directors endorsed CNES' participation in the CALIPSO mission,

Have agreed as follows:

Article I - Purpose

This MOU sets forth the terms and conditions under which the Parties will cooperate in the CALIPSO mission.

Article II - Mission Description and Participation

1. The primary objective of the CALIPSO mission is to collect cloud and aerosol data to allow a better understanding of the role of clouds and aerosols in climate and improve the ability to predict long-term climate change and seasonal to interannual climate variability. The Parties will use lidar, infrared radiometry, and visible imaging techniques to satisfy this objective.

2. A secondary objective is to provide a set of simultaneous coincident data with which to validate and improve data retrievals from NASA's Earth Observing System (EOS) Aqua mission. To satisfy this objective, CALIPSO will adapt its orbit to the EOS Aqua orbit.

3. The CloudSat mission, also selected by NASA under the ESSP-2 AO, will fly in formation with CALIPSO, so that the two satellites can simultaneously collect cloud and aerosol data. It is understood between the Parties that the CloudSat mission will adapt its orbit to the CALIPSO orbit, and that the CloudSat mission will neither create a major interference nor a major impact on the CALIPSO mission. Plans are to co-manifest CALIPSO and CloudSat for a dual launch from a U.S. launch site using a NASA-provided Delta II launch vehicle. The CALIPSO satellite will be in the upper position of the dual configuration.

4. CNES also plans to fly its Polarisation et Anisotropie des Réflectances au sommet de l'Atmosphère couplées avec un Satellite d'Observation emportant un Lidar (PARASOL) mission in formation with CALIPSO so that the two satellites can simultaneously collect cloud and aerosol data. PARASOL will adapt its orbit to the CALIPSO orbit and will neither create a major interference nor a major impact on the CALIPSO or the CloudSat mission.

5. For purposes of this MOU, the payload is defined as the module that contains the instruments, the payload onboard computer, payload data storage and telemetry system and the payload structure. The platform is defined as the structure to which the payload is attached. The flight Star Tracker Assembly (STA) is part of the platform, but is mounted onto the payload. The satellite is composed of the assembled payload and platform and is launched into space.

6. The CALIPSO mission is led by NASA. The CALIPSO satellite, integrated and tested under CNES' responsibility, will consist of a platform, designed and provided by CNES, carrying a payload, under NASA's responsibility, containing instruments to be provided by both Parties. The payload instrument complement will consist of an Infrared Imaging Radiometer (IIR), provided by CNES, and a lidar and a Wide-Field Camera (WFC) provided by NASA. Additionally, NASA will provide the storage required and a payload telemetry system to downlink the payload data, the payload onboard computer, and the payload structure. NASA will be responsible for launching the CALIPSO satellite.

7. The Level 1 Requirements document issued by NASA Headquarters describes the baseline mission as the three-channel lidar, the IIR, and the WFC, flying in formation with a broadband flux instrument and a multi-spectral radiometer--such as the Clouds and the Earth Radiant Energy System (CERES) and Moderate Resolution Imaging Spectrometer (MODIS) on Aqua and Terra--and a minimum on-orbit duration of 3 years. This baseline mission has been agreed upon by both Parties.

8. The CALIPSO mission will collect science data and products for clouds and aerosols. For purposes of this MOU, the following definitions will apply. "X-band satellite telemetry" is data as received from the payload, including sensor and housekeeping data. "Payload science data" is the portion of the X-band satellite telemetry composed of the instrument sensor data. "Science data products" are products resulting from the processing of the payload science data.

9. The CALIPSO satellite is planned to operate for a nominal period of three years. The satellite will be operated by CNES throughout the life of the mission. NASA will command and control the payload by providing payload commands to the CNES satellite control center for uplink. NASA will process X-band satellite telemetry, science data and science data products, as defined in Articles IV and XV below. The X-band satellite telemetry, science data and science data products, as required, will be made available to CNES in a timely manner. There may be satellite expendables remaining at the end of the nominal three-year mission and after a reserve for end-of-life disposal has been established. Any residual expendables, above that required to support disposal, can be used to provide extended satellite operations should the Parties decide to support such extension of the CALIPSO mission. After end of mission, the satellite will be passivated and disposed of in accordance with established NASA and CNES procedures as documented in the CALIPSO Project Plan.

10. Payload science data and science data products will be made available to the CALIPSO science team and the broader international user community according to Article XV below.

Article III - CNES Responsibilities

To implement this cooperative project, CNES, in accordance with the detailed provisions of the CALIPSO Project Plan to be developed by the Parties and defined in Article VII, will use reasonable efforts to:

1. Support the overall systems engineering function for the CALIPSO mission, including support in developing overall system specifications and overall Interface Control Documents (ICDs) which define the NASA/CNES interfaces;

2. Provide satellite engineering, develop a satellite specification document and establish requirements for overall satellite level testing, plan and conduct satellite level tests, evaluate test results, certify satellite flight readiness and provide a Payload Design Interface Specification (PDIS) between the platform and the payload;

3. Design, fabricate, assemble, test and calibrate the IIR, provide an IIR simulator for payload interface verification, transport the IIR and IIR simulator to the NASA-designated integration site, and support integration of the IIR onto the payload;

4. Design, fabricate and test the CALIPSO platform (PROTEUS), including the flight STA;

5. Design, fabricate, and transport a mass model of the STA and the STA's flight wire harness to the NASA-designated site;

6. Integrate the payload onto the CALIPSO platform, perform functional and environmental testing, transport the integrated CALIPSO satellite to the NASA-designated launch site in the U.S. and support launch site processing, as detailed in the CALIPSO Project Plan;

7. Support end-to-end system level testing by performing functional tests of the satellite, including assistance with testing of the payload data telemetry system with NASA-provided ground control and data archival centers;

8. Provide ground support equipment and qualified personnel at appropriate sites to support payload and system integration, testing, launch and operations;

9. Provide NASA with all satellite requirements and constraints necessary for satellite launch, and satisfy all launch vehicle requirements and constraints (e.g., safety requirements) unless formally waived;

10. Perform checkout of the CALIPSO satellite during the launch campaign;

11. Operate the satellite, as required, until the end of the in-flight check-out phase, and operate the satellite on a nominal work week schedule during the routine phase;

12. Design, fabricate, and test the Satellite Operations Ground System (SOGS) which includes the Satellite Operations Control Center (SOCC), based on the PROTEUS Generic Ground Segment (PGGS), the data communication network and the TM/TC Earth terminal (TTCET);

13. Receive and provide to NASA S-band data related to the payload and satellite, as specified in the CALIPSO Project Plan;

14. Perform system level testing between the satellite and the SOGS. This system level testing will also include joint testing with the NASA-provided Payload Operations Control Center (POCC);

15. Perform evaluation and calibration activities, as required and mutually agreed, after launch and according to a schedule defined in the CALIPSO Project Plan, to verify the performance achieved on-orbit by the IIR, and provide results to NASA. Perform analysis and validation of IIR telemetry data during the overall mission, with the assistance of the Institut Pierre Simon LaPlace (IPSL), as required;

16. Develop, with the support of IPSL, IIR science data processing algorithms and test cases for coding and implementation by NASA in its Distributed Active Archive Center (DAAC);

17. Arrange with the appropriate French research organizations to support and prepare the French members of the science teams, French scientists and French users to analyze and validate CALIPSO payload science data and science data products and publish their findings in accordance with Articles VI, XV and XVI below; in particular, in archiving and/or making available, as appropriate, CALIPSO science data products to the scientific community;

18. Arrange with the appropriate French research organizations to support IPSL in processing existing payload science data and science data products;

19. Define and implement the French component of the CALIPSO outreach program; and

20. Inform NASA promptly of any technical or programmatic problems, which may affect overall CALIPSO mission schedules, cost or performance.

Article IV - NASA Responsibilities

To implement this cooperative project, NASA, in accordance with the detailed provisions of the CALIPSO Project Plan to be developed by the Parties and defined in Article VII, will use reasonable efforts to:

1. Provide system engineering, develop overall system specifications and overall ICDs which will define the NASA/CNES interfaces, including support of the payload/platform ICD that demonstrates compliance to the PDIS;

2. Provide requirements for overall payload level testing, the planning and conduct of payload system level tests, evaluation of test results and certification of flight readiness;

3. Design, fabricate, assemble and test the payload onboard computer, payload storage and telemetry system and the payload structure;

4. Design, fabricate, test, and calibrate the NASA instruments, consisting of a lidar and a WFC;

5. Provide the information on interfaces of the payload to the IIR;

6. Provide specifications for the Payload Numerical Simulator for incorporation into the CNES PROTEUS Engineering Simulator Test and Operations (PRESTO) bench;

7. Provide attachment fittings on the payload for mounting the CNES-provided STA and integrate the STA flight wire harness;

8. Assemble, integrate, and test the CALIPSO payload;

9. Design, fabricate and test the NASA-provided ground system, the DAAC, the POCC, the Mission Operations Control Center (MOCC) and the Payload Data Delivery System (PDDS);

10. Perform end-to-end system level testing, including system level testing between the payload data telemetry system and the NASA-provided ground system;

11. Transport the payload to the CNES-designated site, in preparation for satellite integration;

12. Provide ground support equipment including a payload simulator and qualified personnel at appropriate sites to support satellite and system integration, testing, launch and operations;

13. Provide launch services for the CALIPSO satellite which are compatible with PROTEUS capabilities and support CNES' check-out of the CALIPSO satellite during the early operations phase (in-flight check-out phase);

14. Provide CNES with all necessary launch vehicle information as defined in the CALIPSO Project Plan and support CNES in verification of the compatibility of satellite/launch vehicle interfaces;

15. Manage the launch campaign, including launch vehicle integration and pre-launch testing;

16. Perform payload operations and mission management;

17. Perform evaluation and calibration activities, as required and mutually agreed, after launch and according to a schedule defined in the CALIPSO Project Plan, to verify the performance achieved on-orbit by the lidar and WFC, and provide results to CNES;

18. Receive, process and archive X-band satellite telemetry and make X-band satellite telemetry, payload science data and science data products available to CNES via the MOCC, POCC, and DAAC, as required, in a timely manner and in accordance with Article XV;

19. Develop, code and implement in the DAAC, the lidar and WFC science data processing algorithms, and code and implement in the DAAC, the IIR algorithms developed by CNES and deliver the operational code to CNES;

20. Support the U.S. science team members in analyzing and validating CALIPSO payload science data and science data products and in publishing their findings, in accordance with Articles VI, XV and XVI below;

21. Define and implement the U.S. component of the CALIPSO outreach program; and

22. Inform CNES promptly of any technical or programmatic problems, which may affect overall CALIPSO schedules, cost, or performance.

Article V - Project and Program Management

1. A CALIPSO Joint Steering Group (JSG) will be established to provide implementation oversight for the mission. The CALIPSO JSG will be composed of senior level NASA and CNES representatives involved in the development of the CALIPSO mission. The JSG will review project implementation status, resolve implementation conflicts, and provide institutional resources to ensure timely delivery of mission elements.

2. The NASA CALIPSO Principal Investigator (PI) will be responsible for overall mission success. The PI will be supported by a Co-PI from Hampton University and a Co-PI from IPSL. Consistent with the guidelines of the NASA Earth System Science Pathfinder program, the CALIPSO Principal Investigator (PI) has delegated mission implementation responsibility to the CALIPSO Mission Management Team (MMT). The CALIPSO MMT will provide end-to-end mission planning and day-to-day management, and will serve as an interface to the JSG. The MMT will be composed of the NASA CALIPSO Project Manager, the NASA CALIPSO Mission Manager, and the CNES Deputy CALIPSO Project Manager.

Article VI - Science Team and International Science Advisory Panel

1. Science Team

The science team, formed by the NASA CALIPSO PI, will be responsible for the science management of the CALIPSO mission. The Co- PIs from Hampton University and IPSL are members of the science team. The science team may also include other U.S. and non-U.S. scientists, including scientists selected by CNES. Proposed science team members will be agreed to by the PI and Co-PIs and approved by the NASA Associate Administrator for Earth Science.

The CALIPSO science team will be the principal scientific forum for instrument oversight, algorithm development, validation of science data, and initial science data evaluation studies. Additionally, the science team may select scientists with an expertise in the area, to perform science data evaluation. The Parties reserve the right to establish guest investigator programs for validation and science data evaluation studies.

The CALIPSO PI, supported by the Co-PIs, will be responsible for the development of the scientific aspects of CALIPSO and for assuring that the science data products are effectively used and that the results are expeditiously produced and made available, according to Article XV below. They will also be responsible for coordinating science requirements, plans and field experiments with other organizations.

2. International Science Advisory Panel (ISAP)

An ISAP, headed by the Co-PI from Hampton University will be established to provide advice on the science goals of the CALIPSO program, provide an independent assessment of its scientific progress, expand the usefulness and application of its science data products, and provide a vehicle

for broad international collaboration. The ISAP will be composed of four to seven eminent atmospheric scientists, who will represent the CALIPSO data user community and who will be selected by the Co-PI from Hampton University, in consultation with the NASA CALIPSO PI and the Co-PI from IPSL.

Article VII - Project Plan

1. The NASA CALIPSO Project Manager will prepare, in close coordination with the CNES Deputy Project Manager, a CALIPSO Project Plan, which will then be subject to approval by the Parties. In case of conflict between the CALIPSO Project Plan and this MOU, the MOU will prevail. This plan will detail how this cooperative project will be carried out, including mission planning, provision of the satellite, instruments and ground systems, description of interfaces, conduct of mission operations (including end of mission disposal) and data delivery, overall delivery schedule, plan for formal and informal reviews, process and configuration control, delivery timelines for X-band satellite telemetry, payload science data and science data products, and other such information as the NASA CALIPSO Project Manager and CNES Deputy Project Manager deem necessary for project control.

2. To ensure mission success, NASA and CNES will provide mutual insight into the elements under their respective responsibility, consistent with Article XIII of this MOU. Details of the insight to be provided will be described in the Project Plan.

3. Meetings and reviews required to carry out the responsibilities set forth in this MOU will also be included in the CALIPSO Project Plan, and will be held periodically in the United States, France and at other sites as mutually agreed. The schedule, scope and responsibilities of technical and programmatic reviews will be defined in the CALIPSO Project Plan. These reviews will be chaired by NASA and/or CNES, as appropriate. The Parties agree to always invite each other to these meetings and reviews.

4. The Parties will use reasonable efforts to carry out their respective responsibilities in accordance with the schedules to be defined in the CALIPSO Project Plan, and to avoid changes that will have a negative effect on the other Party with regard to scientific return, implementation approach, cost, and/or schedule, and where they cannot be avoided, to minimize these negative effects. To the extent that changes made by NASA or CNES to the CALIPSO Project Plan cause schedule, or other problems that go beyond either Party's program constraints, the MMT will discuss potential options to address such problems, and submit their proposals to the JSG for approval.

Article VIII – Mission Reviews, Integration and Flight Readiness

1. To implement the CALIPSO mission, there will be a series of mission reviews to evaluate the readiness of the flight and ground segments to proceed to implementation, integration, test, and final launch preparation. Representatives from both Parties will serve on the boards of these

reviews. Both Parties will furnish engineering and programmatic data and will participate in these mission reviews, as mutually agreed. All mission review details will be included in the CALIPSO Project Plan.

2. NASA and CNES will jointly:
   Make a final determination of the overall readiness to proceed with integration of the platform and the payload;
   Make a final determination on the readiness of the satellite for integration with the launch vehicle; and
   Make a final determination of the overall readiness of the CALIPSO satellite for launch.

Article IX - Exchange of Personnel

To facilitate coordination related to the CALIPSO mission, the Parties will support the exchange of a limited number of liaisons from each Party, at a time and under conditions as mutually agreed by the NASA CALIPSO Project Manager and CNES Deputy Project Manager pursuant to necessary administrative authorizations. In the event of such an exchange, the Parties each will provide necessary office space and administrative support at the host location, including such additional support services as may be agreed by the NASA CALIPSO Project Manager and CNES Deputy Project Manager. Salary and all other personnel expenses, living and travel expenses, will be borne by the employing Party of the liaison(s) throughout the duration of their assignment.

Article X - Funding

Each Party will bear the costs of discharging its respective responsibilities under this MOU, including travel and subsistence of each Party's personnel and transportation of its own equipment and associated documentation. The obligations of the Parties under this MOU are subject to their respective funding procedures and the availability of appropriated funds.

Article XI - Customs and Taxes

Each Party will use reasonable efforts to arrange free customs clearance and waiver of applicable duties and taxes for equipment and related goods necessary for the implementation of this MOU. Such arrangements will be fully reciprocal. In the event that any customs fees and/or taxes of any kind are still levied on the equipment and related goods for implementation of this MOU, after seeking to develop the necessary free customs clearance and waiver of applicable duties and taxes, such customs fees and/or taxes will be borne by the Party of the country levying the fees and/or taxes.

Article XII - Ownership of Elements and Equipment

For the purposes of this MOU, each Party will retain ownership of elements and equipment it furnishes to the other Party. Any equipment not launched into space will be returned to the furnishing Party at such time as mutually agreed. Each Party will transport its equipment to the designated delivery points, as specified in the CALIPSO Project Plan, and, where appropriate, from such delivery points, when the equipment is to be returned to the furnishing Party.

Article XIII - Exchange of Technical Data and Goods

The Parties are obligated to transfer only those technical data (including software) and goods necessary to fulfill their respective responsibilities under this MOU, in accordance with the following provisions:

1. The transfer of technical data for the purpose of discharging the Parties' responsibilities with regard to interface, integration, and safety will normally be made without restriction, except as required by national laws and regulations relating to export control or the control of classified data. If design, manufacturing, and processing data, and associated software, which is proprietary but not export controlled, is necessary for interface, integration, or safety purposes, the transfer will be made and the data and associated software will be appropriately marked. Nothing in this article requires the Parties to transfer goods or technical data contrary to national laws and regulations relating to export control or control of classified data.

2. All transfers of proprietary technical data and export-controlled goods and technical data are subject to the following provisions. In the event a Party finds it necessary to transfer goods which are subject to export control or technical data which is proprietary or subject to export controls, and for which protection is to be maintained, such goods will be specifically identified and such technical data will be marked with a notice to indicate that they will be used and disclosed by the receiving Party and its related entities (e.g., contractors and subcontractors) only for the purposes of fulfilling the receiving Party's responsibilities under the programs implemented by this MOU and that the identified goods and marked technical data will not be disclosed or retransferred to any other entity without the prior written permission of the furnishing Party. The receiving Party agrees to abide by the terms of the notice, and to protect any such identified goods and marked technical data from unauthorized use and disclosure, and also agrees to obtain these same obligations from its related entities prior to the transfer.

3. All goods, marked proprietary data, and marked or unmarked technical data subject to export control, which are transferred under this MOU, will be used by the receiving Party exclusively for the purposes of the programs implemented by this MOU.

Article XIV - Invention, Patent and Intellectual Property Rights

1. In the event that an invention is jointly made by employees of the Parties, their contractors or subcontractors, during the implementation of this agreement, the Parties will consult and agree as to the responsibilities and costs of actions to be taken to establish and maintain patent protection for such invention and on the terms and conditions of any license or other rights to be exchanged or granted by or between the Parties.

2. Nothing in this MOU will be construed as granting or implying any rights to, or interest in, patents owned or inventions which are independently developed by the Parties or their contractors or subcontractors.

Article XV – Science Data Policy

Access to CALIPSO science data will be as follows:

1. In all cases, the Parties will provide immediate access to all CALIPSO payload science data and science data products, free of charge, for members of the science team, as well as designated representatives of science team members, including associates, staff and co-workers. The Parties will also provide free of charge, payload science data and science data products necessary to the scientists selected for validation.

2. NASA has the responsibility to make science data products available to the public and the science community in a Hierarchical Data Format (HDF)-standard data format after the appropriate science calibration and validation, at no more than the cost of fulfilling the user request. In order to promote rapid access to science data products, some preliminary science data products will be archived after initial verification, but prior to full validation, and made available to all users at no more than the cost of fulfilling the user request.

3. All X-band satellite telemetry, payload science data and science data products obtained from the CALIPSO mission will be archived in appropriate NASA data centers as defined in the CALIPSO Project Plan. Copies of the CALIPSO science data products will be exchanged between the Parties.

4. The CALIPSO science team members (including designated representatives) and scientists selected for validation must provide a report to the Parties on the results of their analysis and validation investigations.

5. All users, including the CALIPSO science team members and scientists selected for validation, should provide a report to the Parties on the results of their investigations on validated CALIPSO science data.

6. Notwithstanding any termination of this MOU by either Party, any X-band satellite telemetry and science data products obtained from the CALIPSO mission, as defined in the

CALIPSO Project Plan, will be archived by NASA for at least 10 years after completion of the CALIPSO mission, unless otherwise agreed by the Parties.

7. The Parties will provide mutual access to science data products from their separate, but related missions, EOS-Aqua, CloudSat and PARASOL. The Parties will agree on the terms of data access. If deemed of interest for scientific analysis of CALIPSO data, the Parties may agree to provide mutual access to correlative data products from other missions.

8. To enhance scientific analysis of CALIPSO data, coordinated Announcements of Opportunity may be issued by the Parties.

Article XVI - Publication of Public Information and Results

The Parties retain the right to release public information regarding their own activities under this MOU. The Parties will coordinate with each other in advance concerning public information activities, which relate to the other Party's responsibilities or performance under this MOU.

The analyzed results obtained from the CALIPSO mission will be made available to the general scientific community through publication in appropriate journals or presentations at scientific conferences as soon as possible and consistent with good scientific practices. In the event that such reports or publications are copyrighted, the Parties will have a royalty free right under the copyright to reproduce, distribute and use such copyrighted work for their own purposes.

In the event a Party or its investigators publish results primarily obtained from CALIPSO science data, or other information regarding results obtained from the implementation of this MOU, the Party or its investigators involved with the publication will make this information available to the other Party, and each Party will, at minimum, have a royalty free right to reproduce, use, and distribute the publication for its own purposes.

In no event will a Party include in a publication export controlled or proprietary technical data or information on technical goods furnished by the other Party, in accordance with Article XIII of this MOU, or information disclosing the other Party's inventions before patent application, without the other Party's prior written consent.

Article XVII – Liability

(a) The purpose of this Article is to establish a cross-waiver of liability between the Parties and their related entities in the interest of encouraging participation in the exploration, exploitation, and use of outer space. This cross-waiver of liability will be broadly construed to achieve this objective.

(b) As used in this cross-waiver,

(1) the term "Related Entity" means:

(i) a contractor or subcontractor of a Party at any tier;
(ii) a user or customer of a Party at any tier; or
(iii) a contractor or subcontractor of a user or customer of a Party at any tier. "Contractors" and "subcontractors" include suppliers of any kind.

(2) the term "damage" means:

(i) bodily injury to, or other impairment of health of, or death of, any person;
(ii) damage to, loss of, or loss of use of any property;
(iii) loss of revenue or profits; or
(iv) other direct, indirect, or consequential damage.

(3) The term "payload" means any property to be flown or used on or in the launch vehicle.

(4) The term "launch vehicle" means an object or any part thereof intended for launch, launched from Earth, or returning to Earth which carries payloads or persons, or both.

(5) The term "Protected Space Operations" means all launch vehicle and payload activities on Earth, in outer space, or in transit between Earth and outer space done in implementation of this MOU. Protected Space Operations begins upon entry into force of this MOU and ends when all activities done in implementation of this MOU are completed. It includes, but is not limited to:

(i) research, design, development, test, manufacture, assembly, integration, operation, disposal, or use of launch or transfer vehicles, payloads, or instruments, as well as related support equipment and facilities and services;

(ii) all activities related to ground support, test, training, simulation, or guidance and control equipment and related facilities or services. "Protected Space Operations" excludes activities on Earth which are conducted on return from space to develop further a payload's product or process for use other than for launch vehicle-related activities necessary to complete implementation of this MOU.

(c) (1) Each Party agrees to a cross-waiver of liability pursuant to which each Party waives all claims against any of the entities or persons listed in sub-paragraphs (c)(1)(i) through (c)(1)(iii) of this section based on damage arising out of Protected Space Operations. This cross-waiver will apply only if the person, entity, or property causing the damage is involved in Protected Space Operations and the person, entity, or property damaged is damaged by virtue of its involvement in Protected Space Operations. The cross-waiver will apply to any claims for damage, whatever the legal basis for such claims, against:

(i) the other Party;
(ii) a related entity of the other Party;
(iii) the employees of any of the entities identified in sub-paragraphs (i) and (ii) above.

(2) In addition, each Party will extend the cross-waiver of liability as set forth in paragraph (c)(1) of this section to its own related entities by requiring them, by contract or otherwise, to agree to waive all claims against the entities or persons identified in sub-paragraphs (c)(1)(i) through (c)(1)(iii) of this section.

(3) For avoidance of doubt, this cross-waiver of liability includes a cross-waiver of liability arising from the Convention on International Liability for Damage Caused by Space Objects of March 29, 1972, where the person, entity, or property causing the damage is involved in Protected Space Operations and the person, entity, or property damaged is damaged by virtue of its involvement in Protected Space Operations.

(4) Notwithstanding the other provisions of this Article, this cross-waiver of liability will not be applicable to the following:

(i) claims between a Party and its own related entity or between its own related entities;
(ii) claims made by a natural person, his/her estate, survivors, or subrogees for bodily injury, other impairment of health or death of such natural person, except where the subrogee is a Party to this MOU or has otherwise agreed to be bound by the promises of this cross-waiver;
(iii) claims for damage caused by willful misconduct;
(iv) intellectual property claims;
(v) contract claims between the Parties based on the express contractual provisions of this MOU; or
(vi) claims for damage based on a failure of the Parties or their related entities to flow down the cross-waiver.

(5) Nothing in this Article will be construed to create the basis for a claim or suit where none would otherwise exist.

Article XVIII- Registration of Space Objects

CNES will request that the Government of France register the CALIPSO satellite as a space object in accordance with the Convention on Registration of Space Objects Launched into Outer Space of January 14, 1975. Registration pursuant to this section will not affect the rights or obligations of either Party or its Government under the 1972 Convention on International Liability for Damage Caused by Space Objects.

Article XIX – Settlement of Disputes

Any dispute not settled through the mechanisms provided in Article V, or any other issue concerning the interpretation or implementation of the terms of this MOU that cannot be resolved otherwise, will be referred to the appropriate level of management of the Parties for consideration and action.

Article XX - Entry into Force, Duration, Amendment and Termination

This MOU will enter into force upon signature and remain in force until five years after the CALIPSO satellite has been launched. This MOU may be amended and extended by written agreement of the Parties. Either Party may terminate this MOU at any time upon twelve months written notice to the other Party. In that event, the Parties will endeavor to reach agreement on terms and conditions to minimize negative impacts of such termination on other Parties.

Termination of this MOU will not affect a Party's continuing obligations under Articles V, XIII, XIV, XV, XVI, and XVII of this agreement concerning Project and Program Management; Exchange of Technical Data and Goods; Invention, Patent and Intellectual Property Rights; Science Data Policy; Publication of Public Information and Results; and Liability, unless otherwise agreed by the Parties.

Done, in duplicate, in the English and French languages, both texts being equally authentic.

Signed at: Paris, France

Date: June 18, 2003

__Sean O'Keefe_____
FOR THE NATIONAL
AERONAUTICS AND
SPACE ADMINISTRATION
OF THE UNITED STATES

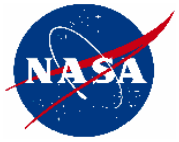
Signed at: Paris, France

Date: June 18, 2003

_Yannick d'Escatha_____
FOR THE CENTRE
NATIONAL D'ETUDES
SPATIALES OF FRANCE

ANNEX B

CNES/NASA Calipso Project Plan



National **A**eronautics and **S**pace **A**dministration
Langley Research Center

Centre **N**ational d'Etudes **S**patiales

- Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations -

(CALIPSO)

NASA/CNES CALIPSO PROJECT PLAN

	Date	Signature
Prepared by: J. Rogers B. Belon		
Approved by: D. Winker M. Pircher J. Newsom		

Revision Record					
REV	**Date**	**Author**	**Approval**	**Description**	**Pages Affected**
	28-Feb-01	J. Rogers B. Belon		Initial Release	ALL
2.0	2 May 2002	J. Rogers B.Belon		New version approved by CCB Change Request CCR-008	ALL
??	Mar '03	J. Rogers B.Belon		……..	……..

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1 *INTRODUCTION*

1.1 BACKGROUND

In April 1998, the Office of Earth Sciences (OES) at NASA Headquarters released the second Earth System Science Pathfinder (ESSP-2) Program Announcement of Opportunity (AO). The ESSP Program's intention was to initiate low cost, quick turn-around missions to accomplish high quality, focused Earth System Science measurements utilizing innovative, streamlined management and implementation approaches designed to yield high value science.

Both NASA and CNES recognized a unique opportunity to develop a mission of mutual interest which fit the above OES criteria and which had as a science objective, to collect data to better understand the role of clouds and aerosols in climate.

A joint proposal, *Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO*)[1] mission, was submitted in response to the AO and after rigorous competition, was selected for development in December 1998 by NASA's Earth Science Enterprise.

NASA and CNES entered into an interim agreement on July 12, 1999, which covers pre-Phase B and Phase B CALIPSO activities.

On the 6th October 1999, the CNES Board of Directors endorsed CNES' participation in the CALIPSO mission.

A Memorandum Of Understanding (MOU) has been agreed upon by NASA and CNES and is to be signed 2003. The MOU defines general responsibilities and the terms and conditions under which both agencies agree to cooperate in the CALIPSO Mission. Much of the international cooperation established during the proposal was based upon previous successful joint missions, namely the TOPEX/Poseidon mission launched in August 1992 and the follow-on Jason-1 mission.

1.2 PURPOSE AND SCOPE

In accordance with the Memorandum Of Understanding (MOU) between NASA and CNES, the Project Plan defines the means by which NASA in the U.S. and CNES in France shall jointly act in cooperation to execute the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission.

The Project Plan is a mutual NASA/CNES plan for developing the systems which support the space, launch, ground, and science segments for the CALIPSO Mission. This plan defines how this cooperative project will be implemented, including:

- mission management (responsibilities, reviews, configuration control, documentation, actions management, confidentiality, schedule management),

[1] Program name at time of selection was Pathfinder Instruments for Cloud and Aerosol Spaceborne Observations (PICASSO-CENA). Name officially changed to CALIPSO Nov 5, 2001

- reciprocal products deliveries and management of their interfaces (launcher, satellite, payload, instruments, ground systems),
- mission operations (responsibilities, data deliveries),
- and other such information as the NASA Project Manager and CNES Project Manager deem necessary for project control.

1.3 MISSION SCIENCE OBJECTIVES

The mission science objective is to collect new information on clouds and aerosols from an orbiting platform to allow improved understanding of climate and climate change. Climate models now predict a significant global warming in response to rising concentrations of carbon dioxide and other greenhouse gases in the atmosphere. However, confidence in these predictions is low because of significant uncertainties in the representations of key physical processes in these models. The predictive capability of climate models must be improved to enable policy makers to reach balanced decisions on potential mitigation strategies. Recent scientific assessments by the Intergovernmental Panel on Climate Change (IPCC), the National Research Council (NRC), and the report of a recent external advisory panel to NASA all came to the same conclusion: the largest uncertainties in our ability to predict future climate change are associated with the radiative effects of aerosols and clouds. Focused global measurements of aerosols and clouds are required to improve predictive capability. These necessary measurements are not provided by present spaceborne missions.

The CALIPSO mission provides these crucial measurements in a timely and cost-effective manner. The payload combines a 3-channel lidar with two carefully selected passive sensors—Wide Field Camera (WFC), and Imaging Infrared Radiometer (IIR)—to obtain unique data on aerosol and cloud vertical structure and optical properties. The CALIPSO satellite will fly in formation with Aqua to produce a coincident, 3-year, global data set that is essential for accurate quantification of aerosol and cloud radiative effects. CloudSat, another ESSP mission, will fly for two years in formation with CALIPSO to produce complementary science data for cloud structure, physical properties, and their effects on climate. PARASOL, the microsatellite mission recently approved by the CNES Scientific Advisory Committee, will fly in formation with CALIPSO to produce a complementary data set to CALIPSO, Aqua, and CloudSat. These four satellites together with the NASA Aura Satellite are referred to as the “afternoon constellation”.

1.4 SCIENCE AND MISSION REQUIREMENTS

The Level-1 mission requirements for CALIPSO are established in the Level-1 Requirements Document issued by NASA Headquarters. The Level-1 science requirements for the CALIPSO mission and instruments are described in the SMRD (PC-SYS-101).

1.5 BASELINE MISSION

As agreed in the MOU, the science objectives will be achieved by flying the lidar, the Imaging Infrared Radiometer (IIR), and a wide field camera (WFC) in formation with Aqua for a three-year mission life. Science requirements can still be met if the IIR and/or WFC are operated discontinuously during the third year of the on-orbit mission to meet power constraints, if required

1.6 SCIENCE PRODUCTS

Requirements for the science products, including the desired measurements, the necessary ranges and accuracies of the measurements, the means and durations of data transference, and near term archiving are defined in the SMRD (PC-SYS-101).

Management of the science data, including collection, processing, archiving, and dissemination is described in the Data Management Plan (PC-SCI-502). Information on the data product content and format is contained in the Data Products Catalog (PC-SCI-503).

1.7 APPLICABLE DOCUMENTS

The CALIPSO MOU between NASA and CNES (noted above) is the overarching document to which this Project Plan is responsive and is the authority to prevail should there occur conflicts within or with the interpretation of this document. Other applicable documents are shown in Table 1-1 below and are responsive to the Project Plan.

Table 1-1: Applicable Documents (AD)

Document No.	***Document Title***
AD01	Memorandum Of Understanding Between the National Aeronautics and Space Administration of the United States And the Centre National d'Etudes Spatiales of France for Cooperation in CALIPSO Mission
PC-SYS-101/AD02	CALIPSO Science and Mission Requirements Document (SMRD)
PC-SYS-102/AD03	CALIPSO Segments Requirements Document (SRD)
PC-SYS-103/AD04	CALIPSO Mission Operations Concept Document
PC-SYS-801/AD05	CALIPSO Deliverable Item list
PC-SYS-804/AD06	CALIPSO Documents List
PC-PRJ-509/AD07	CALIPSO Configuration Management Plan

2 *MISSION CONSTRAINTS, POLICIES, AND GUIDELINES*

The following constraints, policies, and guidelines are levied on the CALIPSO mission:

a. The CALIPSO Mission is to be accomplished as proposed, and as directed by Dr. Ghassem Asrar's selection letter of December 22, 1999 to Dr. David Winker and in compliance with the ESSP-2 AO. Thus, Level 1 changes to the proposed science objectives, instruments/measurements, mission design, team membership, management approaches, and cost or schedule require approval of the NASA Headquarters Associate Administrator for Earth Sciences and impacts must be coordinated with CNES in accordance with the NASA/CNES MOU and as outlined in Section 8 herein.

b. The CALIPSO Mission is to be accomplished as proposed, as defined by Mr. Brachet's decision of March 8,2000.

c. The Memorandum Of Understanding co-signed by the NASA Administrator and CNES President define the general responsibilities of NASA and CNES and the terms and conditions under which they have agreed to cooperate in the CALIPSO Mission.

d. The direction by the Headquarters Earth Sciences Associate Administrator for the co-manifested launch of the CALIPSO and CloudSat missions, on a launch vehicle of the Delta-II type and subsequent formation flying of the two satellites.

e. The use of the generic PROTEUS platform as the satellite platform with minimized adaptations.

f. The use of the PROTEUS generic ground segment (Control center and one earth terminal) adapted to CALIPSO.

g. The use for Infrared Sensor Modules (ISM's) of IASI Infra Red cameras design, with minimized adaptations

h. The satellite to be launched 2004.

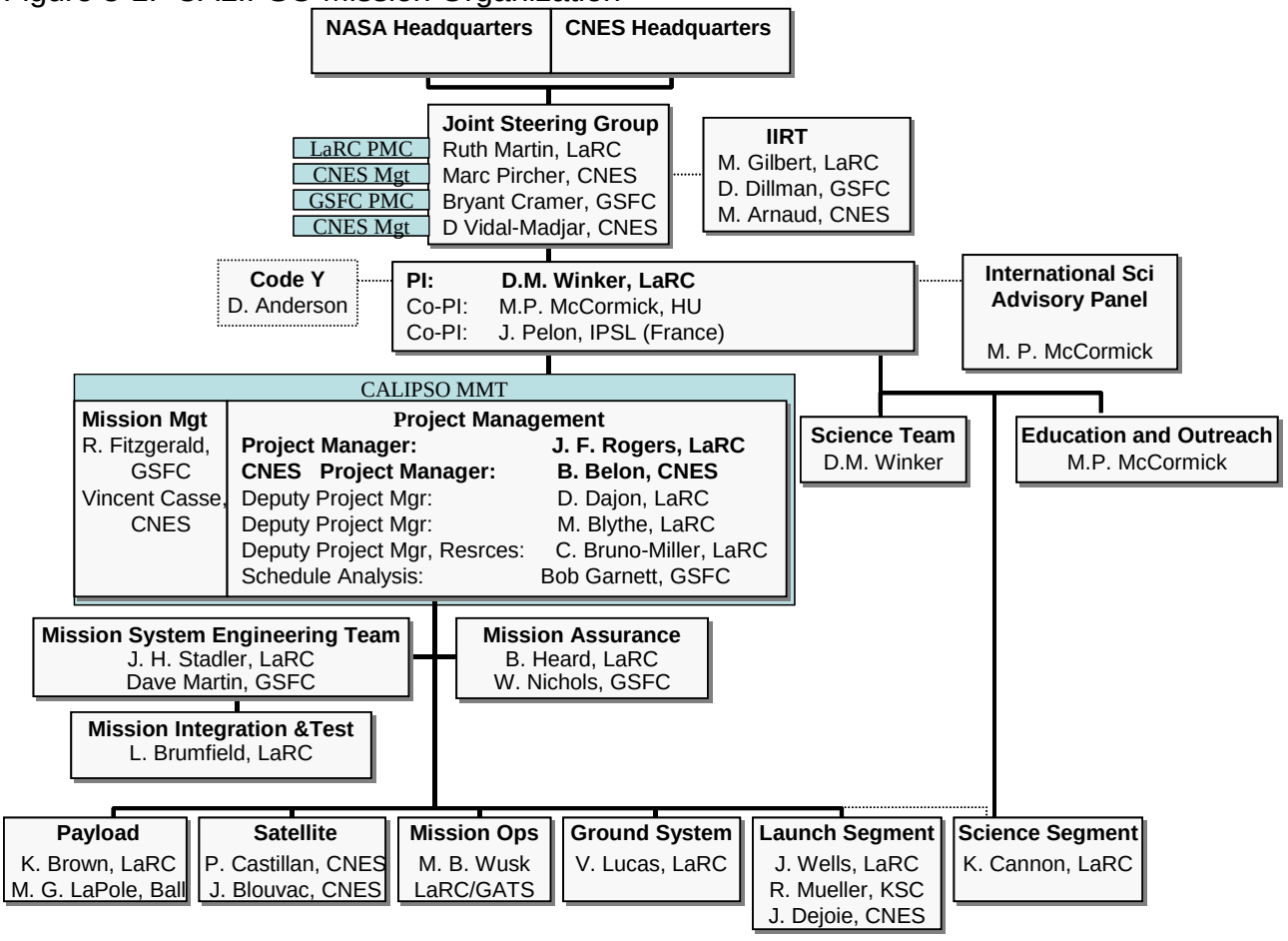
i. All transfers of proprietary technical data and export-controlled goods and technical data as specified in the NASA/CNES MOU, Article XIII.

3 *MISSION MANAGEMENT*

3.1 MISSION ORGANIZATION

The mission organization includes the NASA Langley Research Center (LaRC)/Goddard Space Flight Center (GSFC), the French Centre National D'Etudes Spatiales (CNES), Hampton University (HU), the Institut Pierre Simon Laplace (IPSL), and Ball Aerospace and Technologies Corporation (Ball). The Mission Organization with roles and responsibilities is led by Dr. David Winker of LaRC and is shown below in Figure 3-1.

Figure 3-1: CALIPSO Mission Organization



GSFC is responsible for Mission Management, LaRC is responsible for Mission Science Integrity, Project Management, Systems Engineering, Mission Assurance, and Payload Operations; Ball is responsible for developing the Payload and Payload Data Downlink System; CNES is responsible for satellite engineering, PROTEUS Platform procurement, and for conducting Satellite Operations; Hampton University is responsible for education and outreach and algorithm implementation, and IPSL is responsible for leading the French science activities. Kennedy Space Center (KSC) will provide launch services

under agreement with LaRC. LaRC and CNES team member detailed responsibilities are outlined in chapter 5, “Products Identification and Implementation Responsibilities.” Specific responsibilities for GSFC team members are as follows:

Systems Engineer:

- Supports LaRC Systems Engineer in performing Mission Systems Engineering Functions. Specific duties include:
  - Serve as the GSFC technical coordinator for engineering support to the project
  - Maintains the Mission Verification Plan
  - Updates and maintains the DOORS requirements database
  - Supports HFS/BV2 testing and Payload arrival and integration in France

Quality Assurance Specialist:

- Supports the LaRC Mission Assurance Manager by:
  - Participation in Payload Test Readiness Reviews to ensure that the test procedures and equipment are approved and ready
  - Witness of Payload inspection and cleaning processes
  - Witness of Payload packaging and shipping preparations
  - Witness of Payload receipt and post-shipment check-out at the Satellite Integration & Test Facility and the launch site
  - Providing Quality Assurance and safety oversight at Ball Aerospace, Alcatel, and VAFB

Schedule Analyst:

- Works with LaRC Scheduler to maintain overall project schedule and develop monthly status reporting
  - Assists in project schedule variance analysis and project slack analysis
  - Assists in developing new formats to track schedule progress more closely
  - Assists in maintenance and tracking of project milestones

Business Manager/Resources:

- Supports LaRC Business Manager in budget analysis and reporting
  - Reviews monthly 533 reporting and other financial information
  - Develops monthly financial charts to support GSFC MSR
  - Coordinates funding management and transfer

Systems Assurance Manager:

- Works collaboratively with LaRC Mission Assurance Manager
- Coordinates activities of GSFC Quality Assurance Specialist
- Coordinates use of GSFC Code 300 resources as needed to support the Mission

Flight Software Engineer:

- Supports LaRC Mission Software Manager in software process review and reporting

Safety Engineer:

- Leads GSFC safety assessment
- Provides input to GSFC Code 300, LaRC and the project

Mission Design Analyst:

- Supports LaRC Systems Engineer in performing and reviewing mission design analyses

3.2 JOINT STEERING GROUP

As stated in the MOU, the Joint Steering Group (JSG) provides implementation oversight for the mission. The CALIPSO JSG will be composed of senior level NASA and CNES representatives involved in the development of the CALIPSO mission. The JSG will review project implementation status, resolve implementation conflicts, and provide institutional resources to ensure timely delivery of mission elements.. The JSG will consist of three members including the CNES Orbital Systems Director (co-chair), theNASA GSFC CALIPSO Program Manager (co-chair), and the NASA LaRC Associate Director for Program Integration. and may include additional representatives as agreed upon by the co-chairs.

3.3 MISSION MANAGEMENT TEAM (MMT)

The NASA CALIPSO Principal Investigator (PI) is responsible for overall mission success. The PI has delegated mission implementation responsibility to the MMT. The MMT will provide end-to-end mission planning and day-to-day management, and will serve as the project interface to the JSG. The MMT will be composed of the NASA CALIPSO Project Manager, the CNES CALIPSO Project Manager, and the NASA CALIPSO Mission Manager.

3.4 PROJECT KEY PERSONNEL

The key personnel for the CALIPSO Mission are listed below.

Changes in key personnel will be approved by the respective organizations with consent by NASA as prescribed by the partnering/contractual agreements.

- Principal Investigator (NASA): Dave Winker
- Co-Principal Investigator (IPSL): Jacques Pelon
- Co-Principal Investigator (Hampton University): M. Pat McCormick
- Mission Manager (NASA): Rick Fitzgerald
- Project Manager (NASA): John Rogers
- Project Manager (CNES): Bruno Belon
- Deputy Project Manager (NASA): Debra Dajon

- Deputy Project Manager (NASA): Mike Blythe
- Deputy Project Manager for Resources (NASA): Cindy Bruno-Miller
- Payload Program Manager (Ball): Mark LaPole
- Mission Systems Engineer (NASA): John Stadler
- Deputy Mission Systems Engineer (NASA): Dave Martin
- Launch Segment Manager (NASA): Jim Wells
- Space System Manager (CNES): Patrick Castillan
- Satellite Manager (CNES): Jean Blouvac
- Payload- Platform Interface manager (CNES): Pierric Ferrier
- Payload Implementation Manager (NASA): Alan Little
- Satellite-Launcher Interface manager (CNES): Joel Dejoie
- Ground Segment Manager (NASA): Victor Lucas
- Mission Operations Manager (NASA): Mary Beth Wusk
- Science Segment Manager (NASA): Kim Cannon
- Platform System Manager (CNES): Jean Blouvac
- Payload Manager (NASA): Kevin Brown
- Payload Systems Engineer (NASA): David Rosenbaum
- SOGS Manager (CNES): Paul Gelie
- Operations Manager (CNES): Philippe Crebassol
- MOGS Manager (NASA): Mary Beth Wusk
- NASA Data Manager (NASA): Chris Currey
- French Science Data System Manager (CNES): Anne Lifermann
- IIR Manager (CNES): Thierry Bret-Dibat
- Mission Integration and Test Manager (NASA): Larry Brumfield
- Mission Software Manager (NASA): Bob Estes
- Mission Assurance Manager (NASA): Brent Heard
- Mission Software Quality Assurance Manager (NASA): Leslie Johnson
- Mission Assurance Manager – Satellite (CNES): Christian Martin
- Configuration Manager LaRC: Dimitri Solga
- Configuration Manager CNES Christiane Bringel

Alan Little (NASA) and Pierric Ferrier (CNES) are part time residents respectively and alternatively at CNES and LaRC; as such, they are in charge of NASA-CNES communications facilitating for all NASA-CNES interface topics.

3.5 INTEGRATED TEAMS

In order to improve communication and efficiency between NASA and CNES teams, integrated teams are put in place at Mission and at Satellite level.

The Mission Integrated Team organization is defined in Appendix 3

The Satellite Integrated Team organization is defined in Appendix 4

4 *MISSION AND FLIGHT SYSTEMS DESCRIPTION*

4.1 MISSION (FOR INFORMATION)

The Mission objectives, top level requirements and constraints are defined in the “Science and Mission Requirements Document” (SMRD) (AD 02).

CALIPSO is a mission designed to provide global measurements of aerosols and clouds required for a better understanding of the role of aerosols and clouds in the climate system and to improve our abilities to predict long term climate change and seasonal-to-inter-annual climate variability. The mission has four objectives: 1) Provide a global suite of measurements from which the first *observationally-based* estimates of direct aerosol forcing, and its uncertainty, can be made; 2) Enable the first global *observationally-based* assessment of indirect aerosol radiative forcing; 3) Improve the accuracy of satellite estimates of longwave radiative fluxes at the surface of the Earth and longwave heating rates within the atmosphere by a factor of 2; and 4) Provide a new ability to assess cloud feedback in the climate system, including thin cirrus, polar clouds, and multi-layered cloud systems, all of which are poorly determined by passive radiometers alone. To meet these objectives, the payload combines a 3-channel lidar with a Wide Field Camera (WFC), and Imaging Infrared Radiometer (IIR) to obtain unique data on aerosol and cloud vertical structure and optical properties.

The CALIPSO satellite is to be co-manifested with CloudSat on a Delta II launch vehicle and launched to a quasi sun-synchronous orbit such that it flies in formation with Aqua satellite.

The instruments of the satellite are a three channel lidar, which provides altitude profiles, and two instruments which provide images: the infra-red imaging radiometer (IIR) and the visible wide-field camera (WFC). CloudSat and PARASOL will fly in formation and adapt their orbit to CALIPSO.

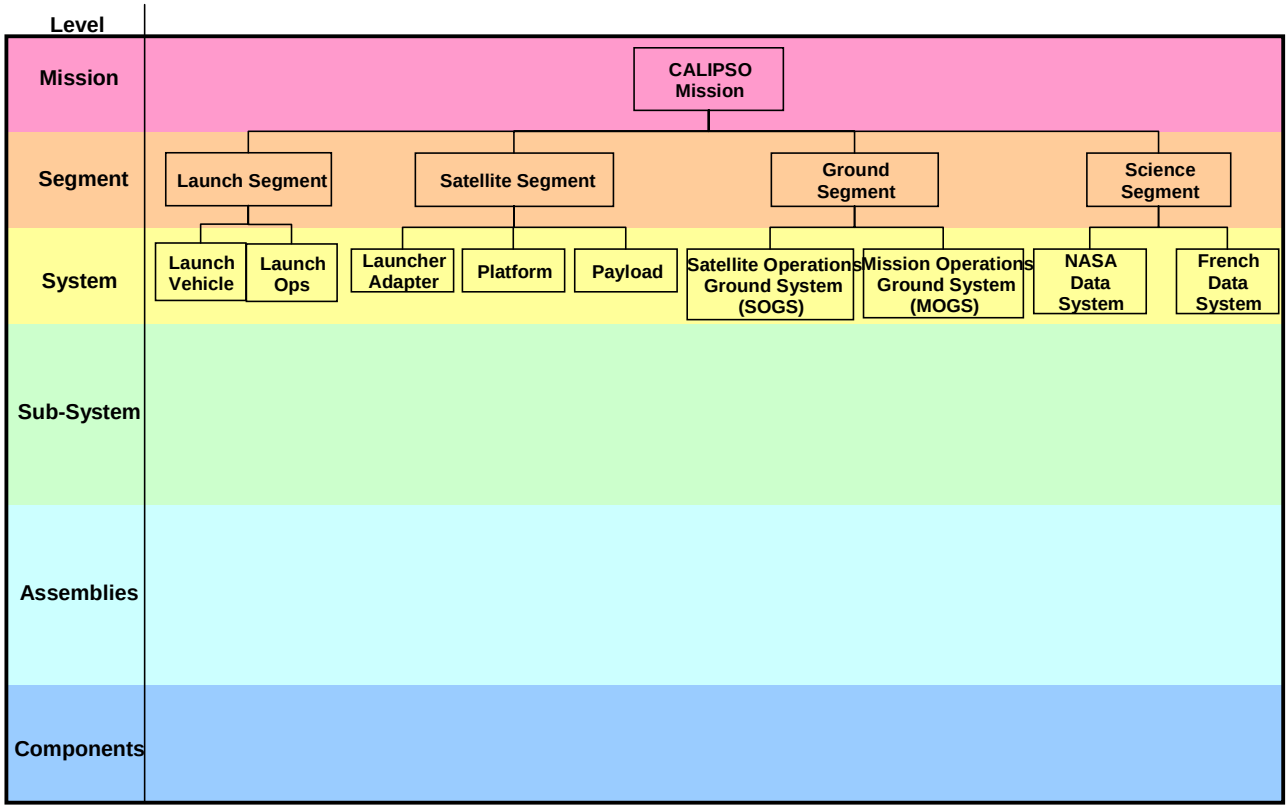
Science data sets will consist of: aerosol and cloud vertical distributions; aerosol extinction, optical depth, and single scattering albedo; cloud extinction, optical depth, and emissivity; Cirrus asymmetry parameter and effective particle size; and surface and atmospheric radiative fluxes.

4.2 SYSTEM ARCHITECTURE (FOR INFORMATION)

The system architecture and requirements are defined in the “Segments Requirements Document” (SRD) (AD03).

The CALIPSO architecture is structured in a top-down succession of levels: Mission level, segments, systems, subsystems, assemblies, and components as shown in Figure 4-1.

Figure 4-1: CALIPSO Mission Architecture



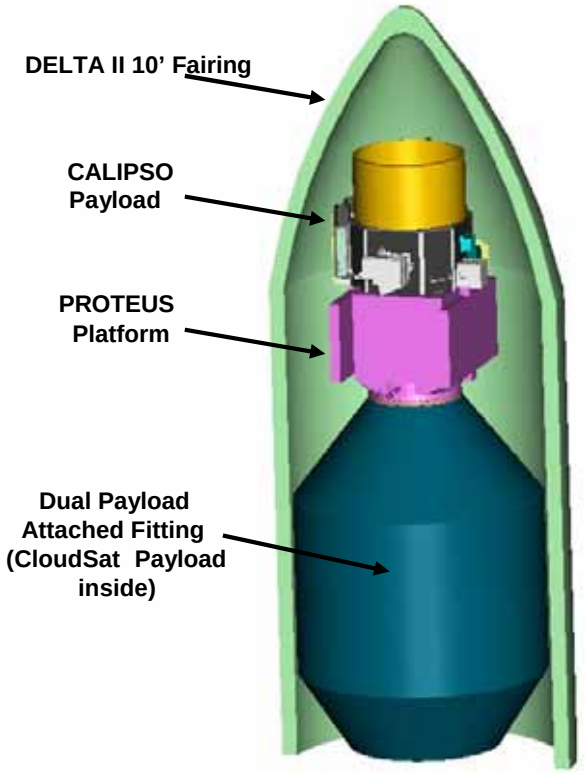
4.2.1 Launch Segment

The launch is manifested by NASA HQ Flight Planning Board. The launch service is managed through Kennedy Space Center's Expendable Launch Vehicle Program via the Med-Lite contract. The launch vehicle segment includes the launch vehicle and the associated launch preparation and operations.

4.2.1.1 Launch Vehicle

The CALIPSO satellite will be launched on a Delta II 7420 – 10 Launch Vehicle in a Dual Launch Configuration with CloudSat. CALIPSO will occupy the upper berth of the Dual Payload Attach Fitting (DPAF) on the Delta II and CloudSat will occupy the lower berth as shown in Figure 4-2.

Figure 4-2: Launch Vehicle DPAF Configuration



4.2.1.2 Launch Operations

Launch Operations will be conducted at Vandenberg Air Force Base primarily using services provided through the Med-Lite contract. Operations will include satellite testing, satellite integration, launch range support, and launch.

4.2.2 Satellite Segment

The satellite includes the platform, the payload and the launcher adapter as shown in Figure 4-3.

Figure 4-3: CALIPSO Satellite

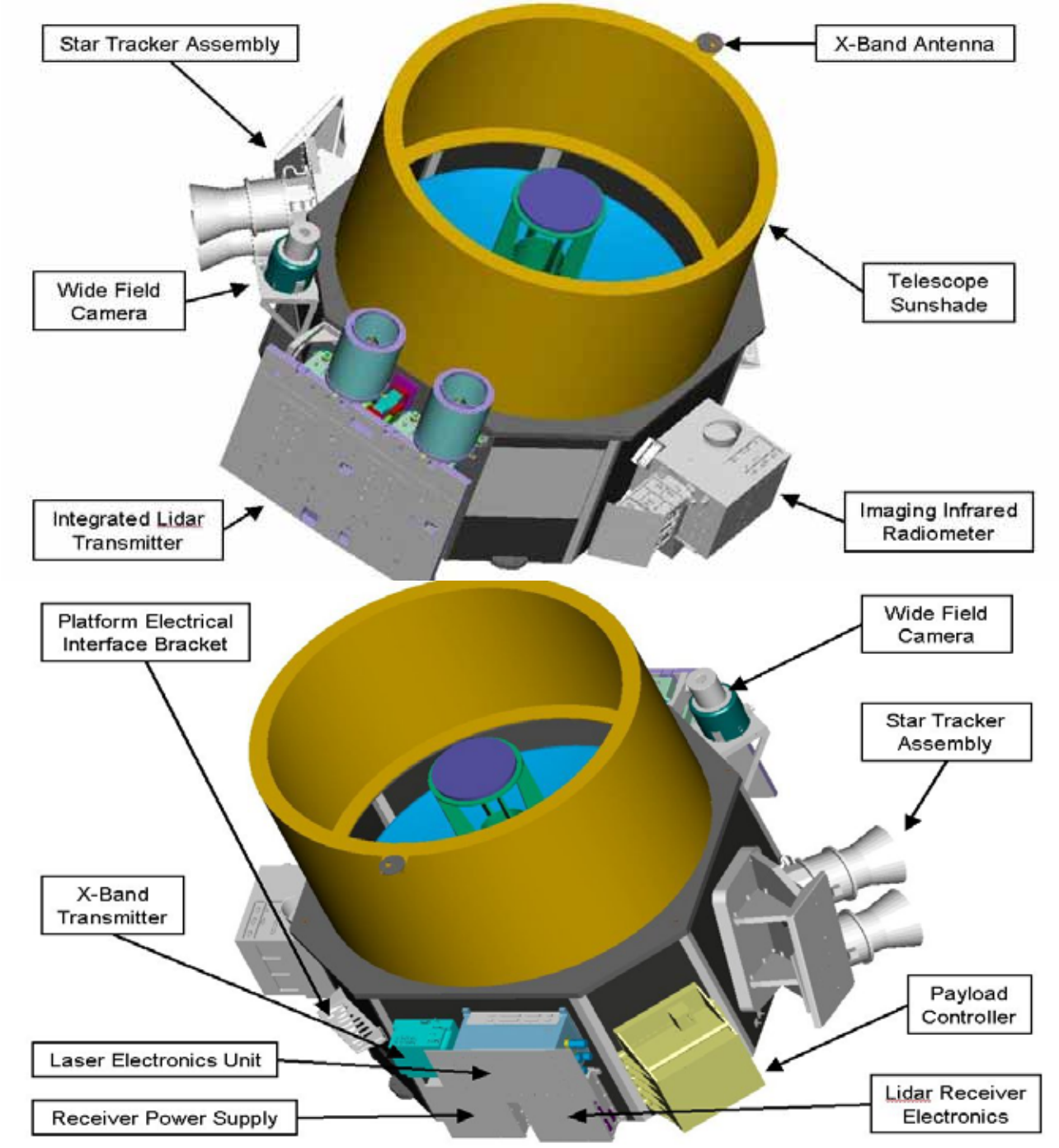
4.2.2.1 Platform

CALIPSO utilizes an Alcatel PROTEUS Platform. The Platform provides the satellite power, attitude control, orbit station keeping, command and control, and S-band up-link and downlink telemetry and telecommand. Additionally, the Platform provides the Payload with discrete and analog channels, which can be monitored on-orbit by the Platform or on the ground. Although the Payload and the Platform are required to be thermally isolated, the Platform provides coarse thermal control to the Payload. Additionally, the Platform provides the following data to the Payload via the Mil-Std-1553B bus: Satellite GPS data, Satellite attitude data, and Time.

4.2.2.2 Payload

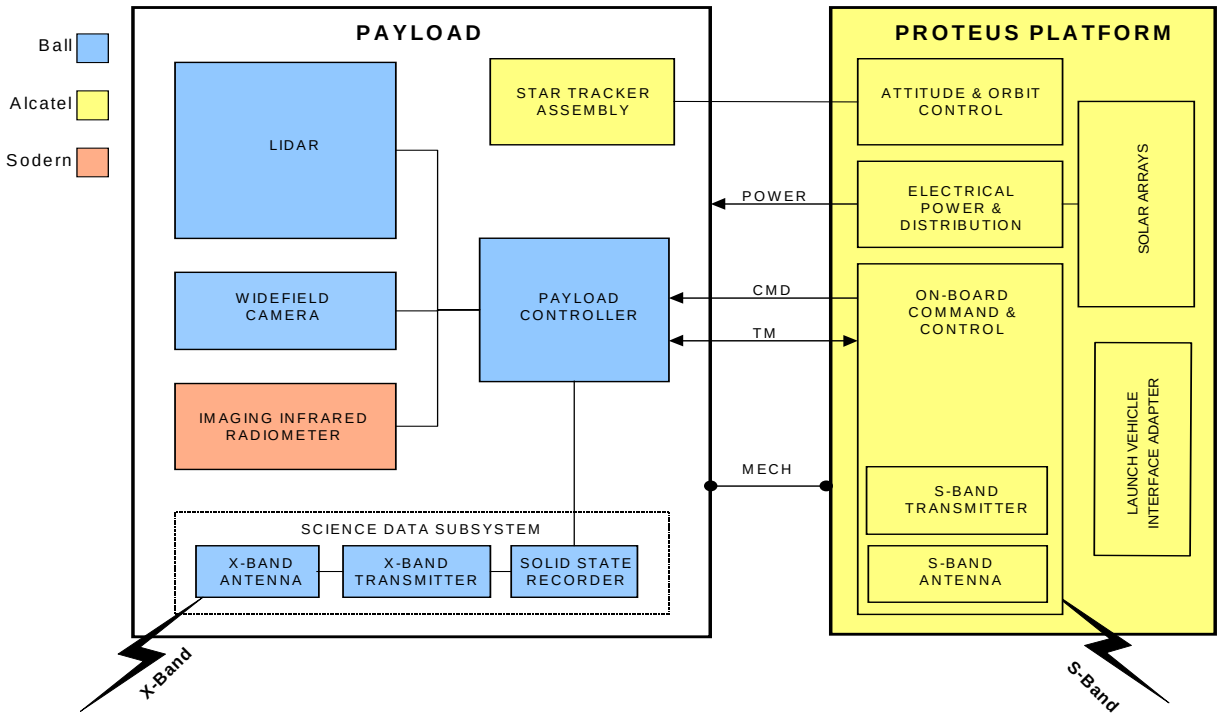
The CALIPSO Payload consists of the suite of three science instruments (lidar, WFC, and IIR), the science data subsystem (SDS), the Payload controller, and the Payload structure. The Payload's data volume exceeds the Platforms S-Band telemetry bandwidth capability. Therefore, the Payload has its own science data storage and downlink subsystem, which consists of a Solid State Recorder (SSR) and an X-band downlink system. The Payload controller collects data from the instruments, commands and controls the Payload, and communicates with the Platform via a MIL-STD-1553B bus.

Figure 4-4: CALIPSO Payload Configuration



The functional breakout of the satellite platform and payload systems and sub-systems and the primary providers are shown in Figure 4-5.

Figure 4-5: Satellite Functional Breakout by System and Provider



The CALIPSO platform is developed under CNES contracts with Alcatel. It will be a protoflight, the qualification of the generic PROTEUS platform being acquired through the PROTEUS program, including the first satellite (Jason) development.

The satellite engineering and AIT is performed under CNES responsibility by CNES and Alcatel under CNES contract.

The CALIPSO Payload is developed under a NASA contract to Ball.

The fully qualified Payload is provided by NASA to CNES for mating to the platform and satellite assembly, integration and environmental testing (AIT).

One of the payload instruments, the IIR, is developed and calibrated by SODERN under CNES contracts.

4.2.3 Ground Segment

The Ground Segment is a distributed segment utilizing NASA, CNES and other resources. It is composed of the SOGS and the MOGS. An overview of the ground segment operation is presented in Figure 4-6.

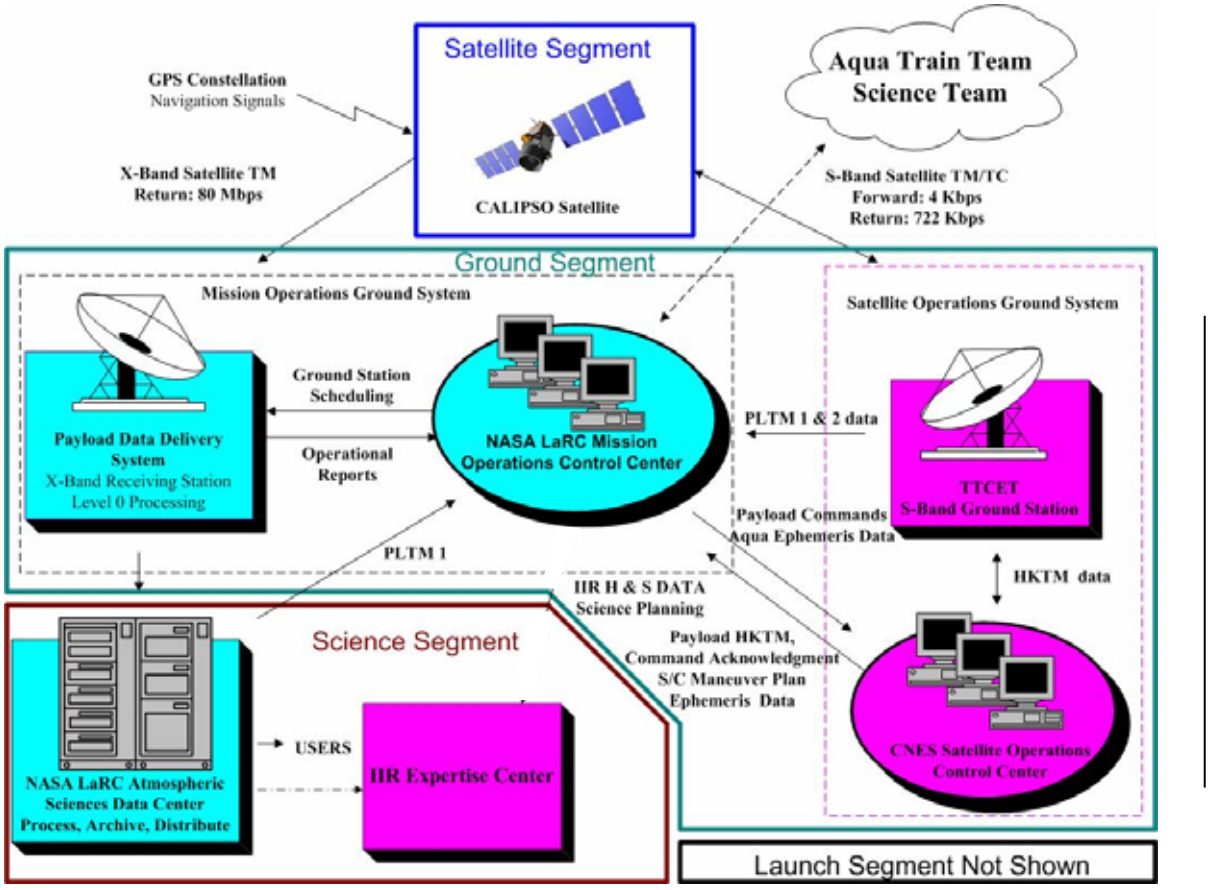


Figure 4-6: CALIPSO Operational Concept Diagram

4.2.3.1 SOGS

The SOGS, located in France, comprises three major sub-systems: the Satellite Operations Control Center (SOCC), the S-Band ground station (TTCET); and the Data Control Network (DCN).

- The SOCC serves as the satellite control center via the S-band telemetry system. Due to similar design requirements, the CALIPSO SOCC will take advantage of the more complex ground system already developed by the JASON project.
- The TTCET S-Band Ground Station supports S-Band command and telemetry functions.

- The DCN provides communication between the SOCC, the S-band ground station, and the internet link to the Mission Operations Control Center (MOCC) in the United States.

The Platform will transmit (either automatically on pre-programmed ground commands or upon ground request) satellite and critical Payload status/health information to the SOCC as required for satellite monitoring. During the Assessment Phase, the SOCC will be staffed as required up to 7 days a week, 24 hours per day. During the Observation Phase, the SOCC will be staffed during a nominal workweek. The SOCC will nominally transmit Platform and Payload commands to the satellite once per week, but provides commanding capability up to four times daily, seven days a week (under anomalous conditions).

The SOGS is developed, validated and operated by CNES

4.2.3.2 MOGS

The Mission Operations Ground System (MOGS), located in the United States, is developed, validated and operated by NASA. It is comprised of two major sub-systems: the Payload Data Delivery System (PDDS) and the Mission Operations Control Center (MOCC).

- The PDDS includes the commercial X-Band Ground Station, the Level 0 processing facility, and the networks required to transfer the data to the Distributed Active Archive Center (DAAC).
- The MOCC will serve as the mission operations control center receiving information from both the X-Band and S-Band telemetry systems, and generating and transferring Payload command builds to the SOCC. The MOCC will autonomously monitor the health and status of the Payload, and perform initial processing of the Payload telemetry data. The MOGS and SOGS will communicate via the standard FTP protocol.

Operational Status: During assessment phase, the MOCC will be manned as required up to 7 days per week, 24 hour per day. During normal operations phase, the MOCC will be manned nominally with on-call support as required. The MOCC will generate the payload commands once per week to be uplinked to the satellite.

4.2.4 Science Segment

The two system components of the Science Segment are the NASA Data System and the French Data System. The Science Segment entails algorithm development and implementation, instrument validation, and data processing, archival, and distribution.

4.2.4.1 NASA Data System: Distributed Active Archive Center

The NASA Data System is the LaRC Distributed Active Archive Center (DAAC) now called the Atmospheric Sciences Data Center (ASDC). The DAAC will perform all science data processing, data archival, and data distribution. Primary data inputs to the DAAC are listed in Table 4-1.

Table 4-1: Data Inputs to the DAAC

Data	Source	Frequency
Level 0 data files (one per instrument) and Health & Status data files	Payload Data Delivery System (PDDS)	Every X-band ground station contact
Quality Control files (one per APID)	Payload Data Delivery System (PDDS)	Every X-band ground station contact
Meteorological Data	GSFC Data Assimilation Office (DAO)	Daily
Ephemeris and Attitude Data	CNES	Daily

The DAAC will process CALIPSO data using the Langley TRMM and Terra Information System (LATIS). All production software, instrument data, and spacecraft ephemeris and attitude data will be processed using the EOSDIS Core System (ECS) science data processing Toolkit. The production schedule for science data products generated by the DAAC is listed in Table 4-2. CALIPSO data products are defined in the Data Products Catalog(PC-SCI-503). The processed data, as well as the raw level 0 data, will be permanently archived at the DAAC. The DAAC will distribute the science data to members of the CALIPSO Science Team at no charge and to all other users for no more than the cost of distribution.

Table 4-2: DAAC Science Data Production Schedule

Level	Data	Production Schedule
1b	Calibrated sensor data	Two-day lag, following completion of the on-orbit checkout.
2a	Lidar backscatter profiles Layer heights/thickness	Preliminary release 135 days after launch, archived after two-year validation period. Data produced on three-day lag thereafter.
2b	Aerosol and Cloud properties	Archived after eighteen month validation period. Data produced on three-day lag thereafter.
4	Surface and atmospheric radiative fluxes	Processed monthly with a 45-day lag.

4.2.4.2 French Data System

The French data system includes the IIR Image Quality Center and the IPSL Scientific Expertise Center in France. The IIR Image Quality Center, located at CNES in Toulouse, will develop IIR Level 1 algorithms, will provide IIR instrument calibration, and IIR instrument health monitoring. The IPSL Scientific Expertise Center, will develop IIR Level 2 algorithms, provide information on IIR instrument performance, and archive, distribute, and process CALIPSO Science data for the needs of the French Scientific Community.

4.2.4.3 Science Algorithms

Science Algorithms will be developed by the Lidar, WFC, and IIR Science Working Groups (SWGs) and will be documented in Algorithm Theoretical Basis Documents (ATBDs) for implementation by LaRC and HU . The Data Management Team will work closely with the SWGs to ensure accurate coding of the algorithms. The SWGs will develop and provide simulated instrument data to the Data Management Team in order to test operational code.

4.2.4.4 Science Data Processing, Archival, and Distribution

The Science Data Processing and Distribution functions are defined in the Data Management Plan (PC-SCI-502).

4.2.4.5 Validation

The On-orbit correlative Validation program is defined in the Science Validation Plan (PC-SCI-501).

4.3 FLIGHT OPERATIONS/PHASES

The operational strategies, roles and responsibilities, team makeup, and concept of CALIPSO mission operations are defined in the Mission Operations Concept Document (MOCD, PC-SYS-103) (AD04).

The primary goal of CALIPSO is to provide data to support U.S., French and international Earth science research. Mission operations will manage the satellite and the ground system to provide good data to the science/user community while remaining within the constraints of available resources. The CALIPSO satellite will collect continuous science data. Stored science data is transmitted via X-band telemetry. Payload and Platform health and status data is transmitted via S-band telemetry. Command loads are transmitted by the S-Band Ground Station.

The 36-month baseline CALIPSO mission is divided into the following five major phases, as defined in the SRD (DA3) and in the MOCD (DA4):

(1) Ground Phase : from integration to launcher ignition

(2) Launch Phase: till satellite separation

(3) Assessment Phase: till satellite in-flight acceptance

(4) Observational Phase: operational phase, includes science (data collection) and non-science (satellite orbit maintenance , non nominal operations), till stop of science operations

(5) End-of-Life Phase: after ceasing science operations (deorbit..)

4.3.1 Flight Operations Roles & Responsibilities

During Assessment Phase, CNES is in charge of conducting the flight operations with the support of NASA.

During Observational Phase, NASA is in charge of conducting the flight operations with the support of CNES.

NASA is primarily responsible for overall coordination of the operations during the observational phase, the operation of the payload, of the MOGS, and the US science data system. CNES is primarily responsible for overall coordination of the operations during the assessment phase, the operation of the satellite (this includes maneuver planning and execution), the SOGS, and the French science data system. The PI, Co-PI's, and the science team are ultimately responsible for the development of the requirements for formation flying.

The CNES Satellite Command & Control Team and the NASA Mission & Payload Operations Team comprise the Flight Operations Team.

Mission & Payload Operations Team (NASA)

The Mission & Payload Operations team is responsible for operation of the MOCC and the PDDS. To reduce cost, operations are conducted during a normal workweek (eight hours per day, five days per week). Additional staffing support will be provided during the assessment phase and during contingency operations. On-call after hours support will be provided with notification via pager. The primary responsibilities of the NASA Mission & Payload Operations Team are:

- Coordinate overall mission operations during observational phase
- Interface with external support facilities to coordinate mission operations
- Plan and schedule payload activities
- Monitor payload health, status, and performance
- Generate payload command builds
- Maintain onboard payload software
- Ensure valid science data is collected and delivered to the DAAC for processing
- Maintain daily operational continuity at the MOCC
- Perform contingency operations as needed

Satellite Command & Control Team (CNES)

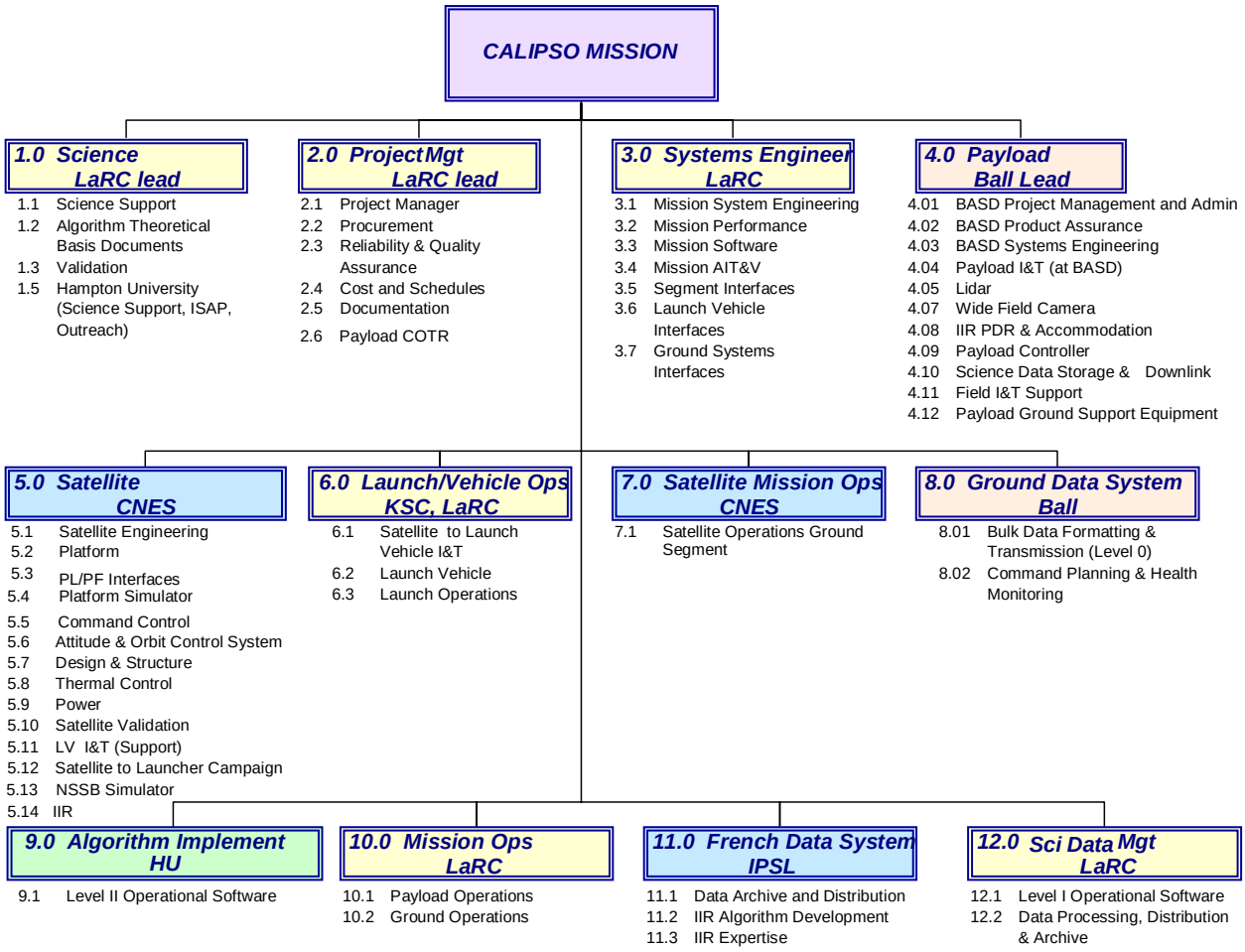
The Satellite Command & Control team is responsible for operation of the SOCC, TTCET, and the DCN. To reduce cost, operations are conducted during a normal workweek (eight hours per day, five days per week). Additional staffing support will be provided during the assessment phase and during contingency operations. On-call after hours support is not planned. (no operational personnel available at the control center during off-peak hours :nights, week-ends, legal holidays, etc.) The primary responsibilities of the CNES Satellite Command & Control Team are:

- Coordinate overall mission operations during assessment phase
- Interface with external support facilities to coordinate satellite operations
- Plan and schedule satellite activities, including maneuvers
- Monitor platform health, status, and performance
- Generate platform command builds
- Maintain onboard platform software
- Uplink the satellite Commands
- Receive and distribute the S-Band telemetry data
- Maintain daily operational continuity at the SOCC
- Perform contingency operations as needed
- Perform orbit determination
- Perform the Proteus Engineering Simulator for Test and Operations (PRESTO)

5 *PRODUCTS: IDENTIFICATION, IMPLEMENTATION RESPONSIBILITIES, AND MAIT*

The product tree follows the Mission Architecture given in Figure 4-1. It is listed below by Agency responsibility, followed by a table describing specific implementation responsibilities. These responsibilities are consistent with CNES and NASA Responsibilities as identified in the NASA/CNES MOU. The products are numbered according to the Mission Work Breakdown Structure (WBS) given below in Figure 5-1. Detailed product trees (segment level) are presented in Appendix 2.

Figure 5-1: Mission Work Breakdown Structure



5.1 PRODUCT IDENTIFICATION AND RESPONSIBILITIES

Table 5-1 defines the products, the applicable numbering of all the products in accordance with the WBS in Figure 5-1, responsibility for the product, and the actual provider.

The column labeled “AGENCIES LEVEL RESPONSIBILITIES” refers to the responsibilities outlined in the NASA/CNES MOU. The Contractor or Provider is the effective provider (writing documents, providing hardware, providing services) of segment, system, or product.

Table 5-1: Product Identification and Responsibilities

PRODUCT	AGENCIES LEVEL RESPONSIBILITY	CONTRACTOR, or PROVIDER
0. Mission Level: CALIPSO Mission	NASA	NASA, LaRC
6 Launch Segment	NASA	NASA, KSC
6.2 Launch Vehicle	NASA	BOEING
6.3 Launch Ops	NASA	NASA, KSC
5 Satellite Segment	CNES	CNES
5.2 Platform	CNES	ALCATEL
5.11 Launcher I/F	CNES	ALCATEL
5.12 PRESTO	CNES	CNES
4.0 Payload	NASA	BALL
4.05 LIDAR	NASA	BALL
4.07 WFC	NASA	BALL
4.09 P/L Controller	NASA	BALL
4.10 Science Data Subsystem	NASA	BALL
4.12 Payload Simulator	NASA	BALL
4.20 IIR	CNES	SODERN
10 Ground Segment	NASA	NASA, LaRC
7.0 Satellite Operations Ground System (SOGS)	CNES	CNES
10.2 Mission Operations Ground System (MOGS)	NASA	NASA, LaRC/BALL
1 Science Segment	NASA	NASA, LaRC
12.0 NASA Data System	NASA	NASA. LaRC
11.0 French Data System	CNES	CNES

PRODUCT	AGENCIES LEVEL RESPONSIBILITY	CONTRACTOR, or PROVIDER
11.2 Scientific Expertise Center	CNES	IPSL
11.3 Technical Expertise Center	CNES	CNES

The specific implementation responsibilities for the mission elements and products are shown in Table 5-2.

TABLE 5-2: IMPLEMENTATION RESPONSIBILITIES

Project level	NASA	- Lead science management - Lead project management - Lead Mission assurance
	CNES	- Support NASA Project & science management - Support NASA mission assurance - Lead science management (French part) - Lead project management (French part) - Lead Mission Assurance (French part)
Mission level	NASA	- lead Mission system engineering
	CNES	- support Mission system engineering
Launch	NASA	– provide contractual interface between the project and the launcher authority – commit for the launcher information & performance – manage the launch campaign – provide launch site facility – provide launcher – provide launcher operations – provide to the satellite in Alcatel a test PAF for dynamical and separation tests – provide to the satellite in Alcatel the Flight PAF for Fit Check

	CNES	- provide technical interface between the satellite and the launcher authority under NASA LaRC contractual responsibility - commit for the satellite information & performance - provide satellite operations on the launch site facility
SATELLITE (see note at the end of the table)	CNES	- lead satellite management - provide satellite engineering - provide the platform - provide payload to platform assembly - provide satellite AIT & functional validation - support the mission level tests - provide to NASA a STA mass model and its Flight wire harness - mount the STA to Payload with Ball support at Alcatel - ship the satellite to launch site
	NASA	- lead payload management - provide payload system engineering - provide the qualified payload to CNES at Alcatel - provide the payload simulator - support satellite AIT (Payload part) - support satellite operations on the launch site (payload part) - support the STA integration onto the Payload at Alcatel - support mission level tests (payload part)

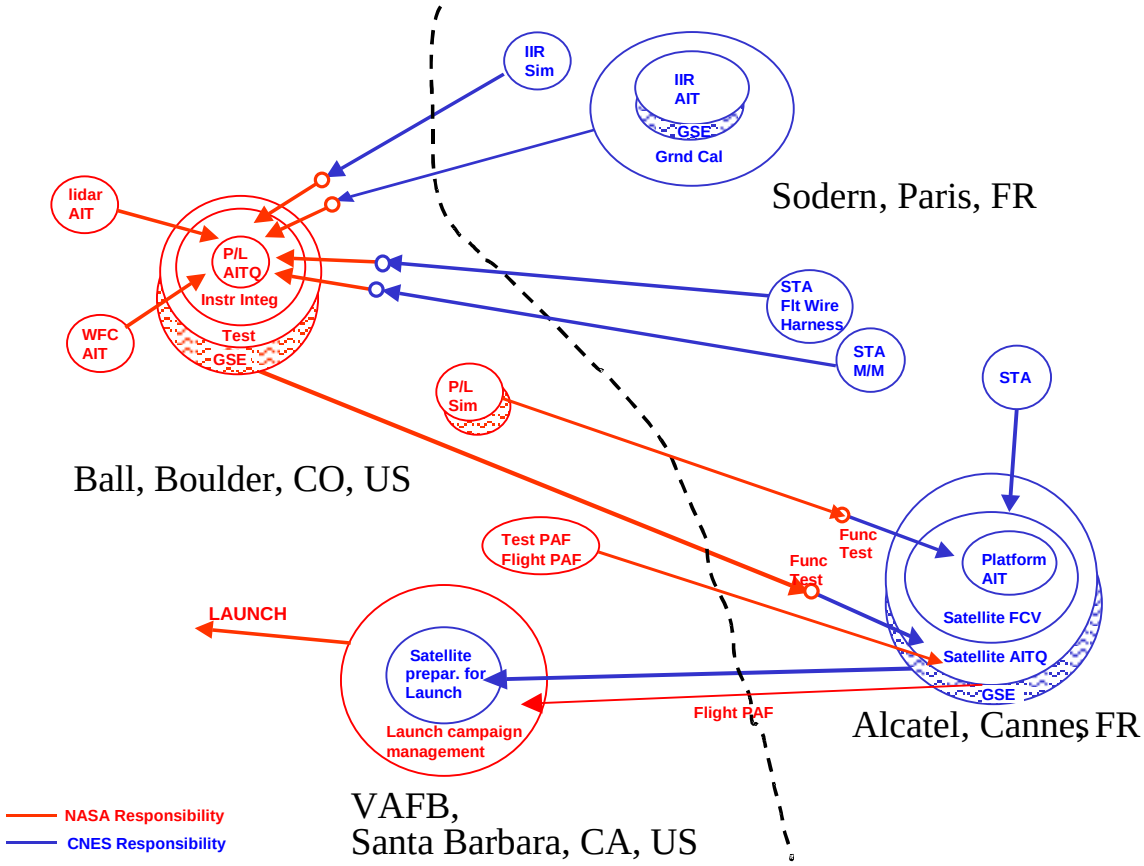
IIR	CNES	- provide the qualified and calibrated IIR - ship the IIR to Ball - provide the IIR simulator to NASA at Ball
	NASA	- manage the IIR/Payload interfaces - develop the IIR mass model - integrate the IIR on the payload
Ground Segment	NASA	- lead ground segment management
	CNES	- support Ground segment management
Satellite Operations Ground System (SOGS)	CNES	- - provide the SOGS - design, fabricate & operate the Presto
	NASA	- *provide Payload Workstations to mirror POCC Workstations for Payload Health & Status Data, Visualization and Command Generation (at CNES) (TBC)*
Mission Operations Ground System (MOGS)	NASA	- provide MOGS
Science segment	NASA LaRC	Lead science segment management- Develop and operate NASA Science Data System Develop the LIDAR and WFC Algorithms - Implement the instrument operational software (including the IIR operational software) - Process all instrument data and make results available to the French Science Data System - Provide a copy of the IIR algorithms operational source software to CNES/IPSL
	CNES	- Develop and operate French Science Data System - Develop the IIR prototype algorithms

RF Frequencies	NASA	- Manage X-Band frequencies regulations topics
	CNES	- Manage S-Band frequencies regulations topics
Mission Operations	NASA	- lead observational phase mission operations - perform Payload commanding and operation - support on-orbit check out
	CNES	- lead assessment phase mission operations - lead satellite operations - perform satellite commanding and operation - provide satellite data telemetry system - lead on-orbit check out

Note: Satellite responsibility definition: The satellite responsibility (CNES responsibility) is related to all that concerns the development, the qualification and the performance of the satellite, except the payload scientific functions (instruments management, instruments measurements, science data management).

Figure 5-2 is a graphical representation describing the responsibilities in Table 5-2 for product exchange related to the satellite: simulators, hardware , flight models, and other GSE.

Figure 5-2: Satellite Product Exchanges



5.2 ASSEMBLY, INTEGRATION, AND TEST

The Assembly, Integration and Test activities follow the general responsibility sharing of the project:

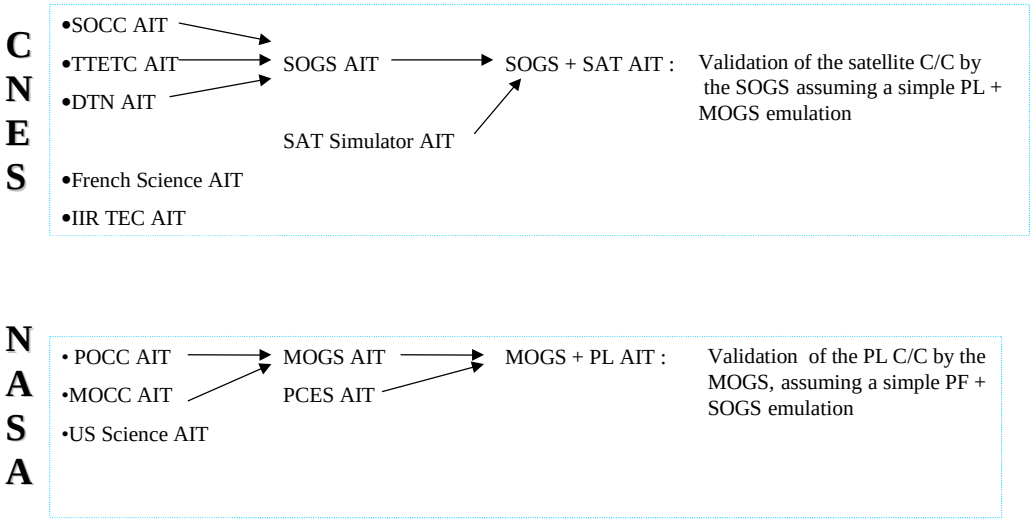
- Mission level NASA
- Launcher NASA
- Satellite CNES
- Platform CNES
- Payload NASA
- PL parts except IIR NASA
- IIR CNES
- Ground Segment NASA
- SOGS CNES

- MOGS NASA
- Science Segment NASA
- NASA data system NASA
- French data system CNES

Each level is in charge of its own validation and of the validation of the interfaces between the parts that compose this level, assuming each part is already validated .

The sequence and responsibilities of the assembly, integration and test of the system is defined by the following schemes:

1 - Elementary - Agency Level- :



2 - INTERFACES

- MOGS + SOGS AIT ↖ NASA + CNES
- MOGS + US Science AIT ↖ NASA
- MOGS + IIR TEC AIT ↖ NASA + CNES
- US Science + French Science AIT ↖ NASA + CNES

3 - END TO END TESTS

	Tests for Assessment Phase	Tests for Operational Phase
MOGS + SOGS +SAT	**CNES + NASA**	**NASA + CNES**
SAT +MOGS + US Science	X	**NASA + CNES**
Whole system : MOGS + SOGS+SAT+US Science + F Science + IIR TEC	. X	**NASA + CNES**

The launcher-satellite interface is dealt in a particular manner: the technical validation of the interface is managed directly by CNES and launcher authority, under NASA/LaRC contractual leadership.

The responsibilities for AIT are also depicted in the next chapter through documentation responsibilities (validation plans and test reports).

6 *DOCUMENTATION*

The overall documentation of the project is defined in the CALIPSO Document List (PC-SYS-804), AD06. This list contains all documents' critical information-- title, document number, configuration control level, description, predecessor, successor, approving organization, delivering organization, responsible person, receiving organization, version, expected date of delivery for delivering organization, expected date of receipt by receiving organization, and actual delivery date. This document follows the configuration control rules.

This chapter addresses major documents which relate to the NASA-CNES cooperative efforts.

6.1 AGENCIES AGREEMENT

Title	Prepared by	Approved by	Concurred by	Released by
MOU	PI, CNES Program Manager, Project Managers	NASA Administrator & CNES President		

6.2 MANAGEMENT DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
NASA-CNES Project Plan	NASA & CNES Project Managers	PI, LaRC Management & CNES Management		
Project Schedule	Project Managers	Project Managers	Mission System Manager and Segment Managers	
Configuration Management Plan	Configuration Manager	Project Managers		
Mission Assurance Documents	Mission Assurance Manager	Project Managers		

6.3 MISSION LEVEL DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
SMRD	PI & Co-PI's	NASA and CNES Program Managers	Project Managers	
SRD	Mission System Manager	Project Managers	Segment Managers	
Mission Validation Plan	Mission System Manager	Project Managers	Segment Managers	
Mission Test Report	Mission system Manager	Project Managers	Segment Managers	
MOCD	Mission Ops Manager	PI, Project Managers	Segment Managers	
Mission Specification	Boeing	KSC	Segment Managers	
Mission I, T, & V Plan	Mission AIT Manager	Project Managers	Segment Managers	

6.4 LAUNCHER INTERFACE DOCUMENTS

The documentation is defined in the CALIPSO Document List (and in Delta 2 planner's guide). The satellite related documentation is prepared by CNES, distributed as draft by CNES to NASA LaRC, NASA KSC, Boeing, Alcatel. The documentation is officially released by NASA LaRC.

6.5 SATELLITE DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Satellite Specification	Satellite Manager(CNES)	Mission System Manager (NASA)	Payload(NASA/ Ball) & Platform(CNES/ Alcatel) managers	Project Managers
Satellite Qualification Plan	Satellite Manager(CNES)	Mission System Manager (NASA)	Payload(NASA/Ball) & Platform(CNES/Alcatel) Managers	Project Managers

Satellite Test Report	Satellite Manager(CNES)	Mission System Manager (NASA)	Payload(NASA/ Ball) & Platform(CNES/ Alcatel) Managers	
PDIS (PL/PF Interface Specification)	PL/PF Interface Manager(CNES)	Satellite Manager (CNES)	Payload(NASA/ Ball) & Platform(CNES/ Alcatel) Managers	Project Managers
Payload Qualification Plan	Payload Manager	Payload Interface Manager (CNES)	Instruments Managers	Project Managers
Payload Test Report	Payload Manager	Payload Interface Manager (CNES)		
IIR Specification	IIR Manager	Payload Manager		CNES Science System Data Manager
IIR Qualification Plan	IIR Manager	Payload Manager		CNES Science System Data Manager
IIR Tests Report	IIR Manager	Payload Manager		

6.6 SATELLITE-GROUND SEGMENT INTERFACE DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Ground to Board Interface Specification	CNES	CNES	Platform Manager Payload Manager SOGS Manager MOGS Manager	Project Managers
Ground to Board Interface	CNES	CNES		

Validation Plan				
Ground to Board Interface Test Report	CNES	CNES		
Payload/MOGS Interface Specification	NASA	NASA		
Payload/MOGS Interface Validation Plan	NASA	NASA		
Payload/MOGS Interface Test Report	NASA	NASA		

6.7 GROUND SEGMENT DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Ground Segment Specification	GS Manager (NASA)	Mission System Manager (NASA)	MOGS Manager(NASA) and Satellite& SOGS System Manager (CNES)	Project Managers
Ground Segment I&T Plan	GS Manager (NASA)	Mission System Manager (NASA)	MOGS Manager(NASA) and Satellite& SOGS System Manager (CNES)	Project Managers
Ground Segment Test Report	GS Manager (NASA)	Mission System Manager (NASA)	MOGS Manager(NASA) and Satellite& SOGS System Manager (CNES)	
SOGS Specification	SOGS Manager (CNES)	Ground Segment Manager (NASA)		Satellite& SOGS System Manager (CNES)

SOGS Validation Plan	SOGS Manager (CNES)	Ground Segment Manager (NASA)		Satellite& SOGS System Manager (CNES)
SOGS Test Report	SOGS Manager (CNES)	Ground Segment Manager (NASA)		Satellite& SOGS System Manager (CNES)
MOGS Specification	MOGS Manager (NASA)	GS Manager (NASA)		
MOGS Validation Plan	MOGS Manager (NASA)	GS Manager (NASA)		
MOGS Test Report	MOGS Manager (NASA)	GS Manager (NASA)		

6.8 SCIENCE SEGMENT DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Science Validation Plan	Science Validation Coordinator	PI & Co-PIs	Science Segment Manager	

6.9 DOCUMENTATION NUMBERING

The following convention will be used for mission documentation:

An eight-digit identifer in the following format (PC-aaa-yxx):

PC = the first and second letters designate the CALIPSO mission.

Aaa = the third, fourth, and fifth letters represent the functional area the document supports according to the following list:

SYS – System Level Document (e.g. SMRD)

SAT – Satellite Document

PLD – Payload Document

PFM –Platform Document

LVH – Launch Vehicle Document

GND –Ground Document

SCI – Science Document

OPS – Operations Document

AGR – Partner Agreement

PRJ – Project Management Document

Y = the sixth number shall designates a document type according to the following list:

1 - Specification

2 - Description Document

3 - Test Document

4 - Operations Document

5 - Programmatic

6 - Reserved

7 - Reserved

8 - Miscellaneous

9 - ICD

XX = Sequential Number of the document

For documentation within Segments or Systems of implementing organizations, the organization's document numbering convention will be used.

6.10 INTERFACE CONTROL

Interfaces are fundamental areas of concern with the CALIPSO project. All interfaces between mission products (segments or systems) are defined in Interface Control Documents (ICDs). The ICDs will be placed under configuration control after they have been developed by the appropriate project personnel and approved by the project management team. Changes to an ICD will use the configuration change control process outlined in the section 8, and detailed in the Configuration Management Plan (PC-PRJ-509).

7 *ALLOCATION MANAGEMENT*

The allocations are defined by common agreement of CNES and NASA in the SRD. Management of the allocations follows the guidance set forth in the tables below with control responsibilities defined as:

Approval — Approval Organization. The controlling organization shall not implement until approval is granted by the appropriate configuration control board (see section 8).

Control — Responsible for generating, maintaining, and distributing budget. Responsible for systems engineering, and performing trade studies.

Information — Information only. No action required.

Concur — Accepts the allocation as applicable

7.1 PERFORMANCE ALLOCATIONS

Lidar Footprint Control/Knowledge	**LaRC**	**CNES**	**LaRC via Ball**
Satellite Requirement	Control	Information	Information
Platform Allocation	Approval	Control	Information
Payload Allocation	Control	Information	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

On-orbit Altitude Knowledge	**LaRC**	**CNES**	**LaRC via Ball**
Satellite Requirement	Control	Information	Information
Platform Allocation	Approval	Control	Information
Payload Allocation	Control	Information	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information		Control

Altitude Knowledge (Post-Processed)	**LaRC**	**CNES**	**LaRC via Ball**
Satellite Requirement	Control	Information	Information
Platform Allocation	Approval	Control	Information

Payload Allocation	Control	Information	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information		Control

7.2 RESOURCES ALLOCATIONS

Mass	**LaRC**	**CNES**	**LaRC (via Ball)**
Launcher Satellite Requirement	Control	Information	Information
Satellite Allocations - Platform - Payload - Launch Vehicle Adapter - Satellite Margin	Concur	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Approval	Information	Control

Power	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	Information
Satellite Allocations - Platform - Payload - Satellite Margin	Concur	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

Volume	**LaRC**	**CNES**	**LaRC (via Ball)**
Launcher Satellite Requirement	Control	Information	Information

Platform Allocation	Concur	Control	Information
Payload Allocation	Concur	Control	Information
Platform Sub-Allocation	Information	Control	Information
Payload Sub-Allocation	Information	Information	Control

S-Band Data Rate	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	
Platform Allocation	Information	Control	
Payload Allocation	Information	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

S-Band Data Volume	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	
Platform Allocation	Information	Control	
Payload Allocation	Information	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

X-Band Data Rate	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Information		Control
Platform Allocation			
Payload Allocation	Information		Control
Platform Sub-Allocation			
Payload Sub-Allocation	Information		Control

X-Band Data Volume	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Information		Control

Platform Allocation			
Payload Allocation	Information		Control
Platform Sub-Allocation			
Payload Sub-Allocation	Information		Control

Delta-V Budget	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	
Platform Allocation	Information	Control	

Platform (including PLTM..) Mass memory Budget: same responsibilities as S-Band

P/L Mass memory Budget: same responsibilities as X-Band

8 *CONFIGURATION MANAGEMENT*

The applicable document for configuration control is The Configuration Management Plan PC-PRJ-509/AD07

8.1 DEFINITION

Configuration management is the systematic process for establishing and maintaining control of all CALIPSO baseline documentation, hardware, and software deliverables (configured items). It ensures that all proposed and actual technical and programmatic changes to CALIPSO configured items shall be systematically evaluated for validity, merit, need, and impact throughout the life cycle of the mission. It ensures that all affected organizations will be cognizant of the impact of such changes (i.e., performance, schedule, and cost) and will have participation in the decision process within an optimum time frame.

The section 8 of the NASA/CNES project plan is applicable to the CALIPSO Configuration Management Plan (PC-PRJ-509) which describes this discipline for the mission in more detail: the CALIPSO Configuration Management Organization, configuration identification, change control, definitions, procedures, and forms.

8.2 GOALS

Goals of configuration management are:

- to know, at all times, the technical description of the system and its components by means of approved documentation
- to control the changes to the technical description of the system
- to facilitate coherence between segment, system, and subsystem items (control of external interfaces), and the products within these entities (control of internal interfaces)
- to check that the documentation is and remains an exact reflection of the products that it describes
- to identify the applicable configuration and the applied configuration in order to deal with deviations and/or waivers detected during the production, delivery or use of the product
- to enable all users to know the possibilities and utilization limits of each example of the product and, in case of anomalies, the examples affected.

8.3 CONFIGURATION MANAGEMENT TASKS

The four main configuration management tasks are.

a. **Configuration Identification**: the technical documentation (plans, specifications, procedures, processes, etc.) and drawings (and their numbering convention) that identify and describe the approved configuration of a product during the project phases.

b. **Configuration Control**: the systematic evaluation, coordination, disposition, and implementation of proposed changes to a configured item. Deviations and waivers are formal changes and included in the configuration control process

c. **Configuration accounting and monitoring**: the recording and reporting of information required for the complete identification of the configuration; the description of all deviations on a product, between the configuration accepted at a given time and the applied configuration of the product.

d. **Configuration verification**: periodic surveys of design, fabrication, assembly, integration, and testing phases to verify that the configuration is identifiable and that changes are traceable to an established baseline and the design drawings and hardware are in conformance.

8.4 CONFIGURATION MANAGEMENT ORGANIZATION

Configuration control will be accomplished through configuration control boards set up according to the following hierarchy and responsibilities:

Configuration Management Hierarchy

Level	Controlled By	Responsible for	CCB Chair	CCB Membership	Sample Types of Baselined Documents
0	NASA Admin Code AE	PCA content	Administrator's Approval Only		- Program Commitment Agreement (PCA) Content
1	GSFC ESSP Project Off.	Science & Mission Level 1 Requirements	Mission Office -- Chairperson defined by Hqtrs (Change recommendations from PI, Dr. Dave Winker)	Determined by Chairperson	- Level I Requirements Document - Science and Mission Requirements Document Sections 2, 3, 4a (Level 1 Requirements) - NASA/CNES Memorandum of Understanding (MOU)
2	P-C PI	Science & Mission Integrity; Mission Level Functions (Cost, schedule, and performance control)	Mission Lead – Chairperson Dr. Dave Winker	- Co-PIs - Project Mgr - Deputy Proj Mgrs - Others as Required	- Descope Plan - ATBDs - SMRD level 2 requirements
3	P-C PM	Ensuring all Mission Segments Work Together to Satisfy Mission Requirements	Project Office -- Chairperson John Rogers	- PI - Deputy Proj Mgrs - System Eng - Mission Assur Mgr - Segment Leads - Others as	- Mission Implementation Plan - SRD (SMRD Sections 4b, 5, 6) - ICDs that describe/contain external interface requirements between Segments - Project Plan

				Required	
4	Segment Leads	Ensuring all Systems within Segments work together to satisfy Mission Requirements	Segment Lead - Individual CCB's	-System Leads - Mission Assur Mgr - Interface Managers - Mission System Engineer	- Segment Specifications - ICDs that describe interfaces between Systems within Segment
5	System Proj Mgrs	Completing Mission Systems	System Developers -- Individual CCBs	Determined by Organization but should include members from affected systems	- Systems Specifications (including drawings) - Internal Interfaces - Data Requirements Descriptions
6	Managing Organizations	Subcontractor Elements	Subcontractors CM Requirements set by customer contract Subcontractor implements CM according to individual company processes and contractual requirements and agreements		- Data Requirements Descriptions
The following Interfaces between systems in different segments will be handled as such: P/F//SOGS→Satellite Segment, P/L//MOGS→Ground Segment. Unresolved change requests at level 4 will be submitted to the CALIPSO Project management for direction. If the CALIPSO Project Management is unable to resolve the differences it will be submitted to the JSG for direction.					

The NASA and CNES CALIPSO Mission Configuration Managers (C Mgr) , for the items under the responsibility of their respective agency, are responsible for:

- Identifying and monitoring the baseline configuration

- Delivering the applicable documents

- Implementing the change process-- initiating instructions, receiving Change Proposals, organizing CCBs, validating changes and archiving change files

- Recording and producing the configuration statuses

- Freezing the configuration baselines during reviews and at milestones.

8.5 CONFIGURABLE ITEMS

8.5.1 Documents

Documents that have been identified as NASA/CNES Configurable Items are indicated in the Document List (PC-SYS-804).

8.5.2 Hardware/Software Deliverables

Hardware and Software that have been identified as NASA/CNES Configurable Items are indicated in the Deliverables Item List (PC-SYS-801)

8.6 CONFIGURATION BASELINES

The configuration management principles are based on establishing and validating baselines from which all changes are formalized and checked. A Configuration Baseline is characterized by a set of documents describing the characteristics of a product. These are the Configuration Baselines for the CALIPSO Mission.

- **Allocation/Requirements Configuration** frozen at end of pre-phase B (SRR). This configuration is baselined by the release of the Science and Mission Requirements Document.

- **Development Configuration** frozen at end of phase B (PDR). The documents identifying this configuration are the Partnering agreements, the SRD (Segments Requirement Document) the, Segment/System Specifications, and Interface Control Documents (preliminary).

- **Production Configuration** frozen at end of phase C (CDR). The documents identifying this configuration are approved engineering designs with final documentation, Integration & test plans/procedures and final Interface Control Documents. At end of phase C, a document will identify the documentation of this configuration.

9 *SCHEDULES AND DEVELOPMENT LOGIC*

9.1 SCHEDULES

There are three levels of schedules that are described in the following sections. The lowest level of schedule (Level III) contains detailed development logic. The next higher level of schedule (Level II) contains a synthesis of the detailed Level III schedules and focuses on key milestones and deliveries between organizations. The highest level of schedule, the Level I or Master Schedule, is a one-page summary of the Project Schedule.

9.1.1 Level I (Master) Schedule

The CALIPSO Mission will be implemented according to the configuration controlled master schedule. This schedule is maintained on Livelink and is accessible to the entire CALIPSO team. This schedule establishes the interrelationships and time phasing of activities and events essential for the timely and effective implementation of the program, and identifies critical paths. This one-page schedule is developed by NASA Langley Research Center using the Level II schedule as input.

9.1.2 Level II (Project) Schedule

The Level II schedule is based on a synthesis of each component schedule (Level III schedule) and delivered to LaRC. The level II schedule is focused on key milestones and deliverable dates. The schedule is configuration controlled and is maintained on Livelink. The schedule is accessible to all members of the project. Each organization is responsible for providing an input Microsoft Project file that NASA uses to generate the Level II schedule. NASA is responsible for integrating the elements of the Level II schedule. The Project schedule is managed jointly by NASA and CNES.

9.1.3 Level III (Detailed) Schedules

The Level III schedule is developed by the organization responsible for the product. This schedule is used internally by that organization and is not provided to the Project (NASA). The Level III schedules contain the detailed development logic, durations, and critical paths of the component items and are closely managed. The Level II schedule is developed from this detailed schedule.

9.1.4 Schedule Maintenance

The Level I and II schedules are maintained under configuration control by the Project Office. These schedules will be statused on a weekly or monthly basis as required. Milestones in danger of slipping will be immediately assessed for impact to mission partners.

10 *MISSION REVIEWS*

10.1 MISSION REVIEWS: PURPOSE AND CONVENING AUTHORITIES

Meetings and reviews required to carry out the responsibilities set forth in the MOU will be held periodically in the United States, France and at other sites as mutually agreed.

Mission level reviews will be conducted on approximately one-year intervals to ensure satisfactory progress in meeting mission requirements. These reviews will be conducted in accordance with the Integrated Independent Review Plan.

The purposes of the reviews are to provide an independent assessment of the continuing ability of the Mission to meet its technical and programmatic commitments and to provide value-added assistance to the Project Managers as required.

Major project reviews are conducted according to the following mission architectures.

a) Mission (Segments: launch, satellite, ground, science);

b) System (Platform, payload….)

c) Subsystem (Instruments..).

For the MCR and MRR, the reviews will be chaired by the GPMC and CNES will be a voting member. Both Parties will furnish engineering and programmatic data and will participate in these mission reviews, as mutually agreed.

TABLE 10-1: MISSION LEVEL REVIEWS

Review	***Appr Dur***
MCRR	2-3 hrs
MRR	2-4 hrs
MDR	2 days
PSR	1 day
CDR	2 days
PSRR	2 days
FRR	½ day

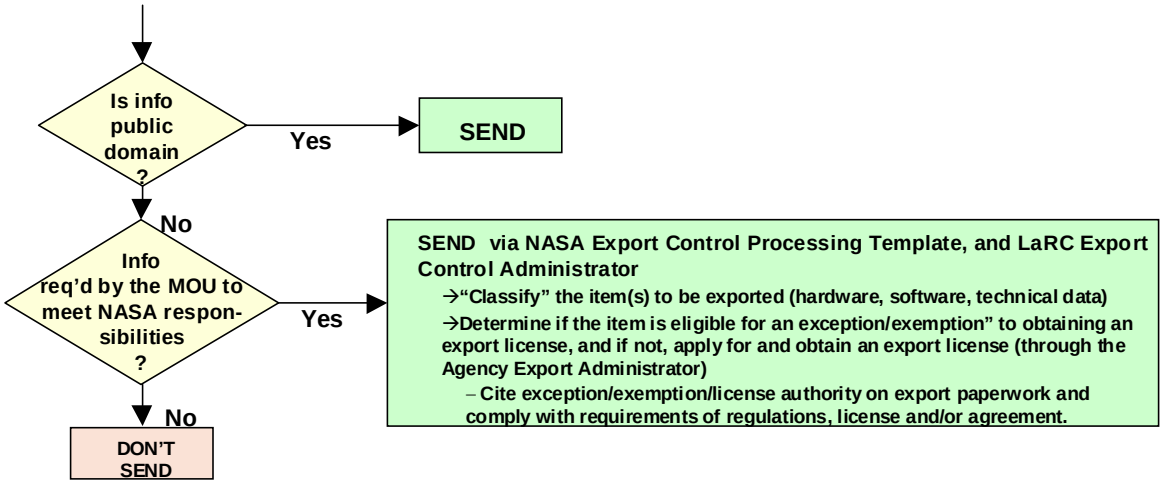
10.2 MISSION REVIEW BOARD

LaRC and CNES will strive to help maintain consistent chairperson(s) and committee members for all reviews.

11 *DATA AND INFORMATION POLICY*

Data and information will be exchanged in accordance with the MOU, national laws and regulations, Technology Transfer Control Plan (PC-PRJ-514), and industry regulations. The process used to export data and information is described in Figure 11-1.

Figure 11-1: ITAR EXPORT PROCESS



11.1 REVIEWS

The Payload Design Reviews are segmented as follows:

- Segment 1: Open to full international participation; will meet NASA's responsibilities--interface, integration, safety, mission development, test plans; consistent with the NASA/CNES MOU

- Segment 2: Tabletops restricted to U.S. participation; review of detailed design, development, production, and manufacture data

11.2 SCIENCE DATA POLICY

According to the NASA/CNES MOU, access to science data will be as follows:

1. In all cases, the Parties will provide immediate access to all CALIPSO payload science data and science data products, free of charge, for members of the science team, as well as designated representatives of science team members, including associates, staff and co-workers. The Parties will also provide free of charge, payload science data and science data products necessary to the scientists selected for validation.
2. Science data products will be made available to the public and the science community by NASA in a Hierarchical Data Format (HDF)-standard data format after

the appropriate science calibration and validation, at no more than the cost of fulfilling the user request. In order to promote rapid access to science data products, some preliminary science data products will be archived after initial verification, but prior to full validation, and made available to all users at no more than the cost of fulfilling the user request.

3. All X-band satellite telemetry, payload science data and science data products obtained from the CALIPSO mission will be archived in appropriate NASA data centers as defined in the CALIPSO Project Plan. Copies of the CALIPSO science data products will be exchanged between the Parties.
4. The CALIPSO science team members (including designated representatives) and scientists selected for validation must provide a report to the Parties on the results of their analysis and validation investigations.
5. All users, including the CALIPSO science team members and scientists selected for validation, should provide a report to the Parties on the results of their investigations on validated CALIPSO science data.
6. Notwithstanding any termination of this MOU by either Party, any X-band satellite telemetry and science data products obtained from the CALIPSO mission, as defined in the CALIPSO Project Plan, shall be archived by NASA for at least 10 years after completion of the CALIPSO mission, unless otherwise agreed by the Parties.
7. The analyzed results obtained from the CALIPSO mission will be made available to the general scientific community through publication in appropriate journals or presentations at scientific conferences as soon as possible and consistent with good scientific practices. In the event that such reports or publications are copyrighted, the Parties shall have a royalty free right under the copyright to reproduce, distribute and use such copyrighted work for their own purposes.

12 *PROJECT MANAGEMENT PROCESSES*

12.1 PROJECT REPORTING

A Monthly Report is prepared by LaRC for NASA and CNES management which includes the following Information;

- Project Status (Fever Chart)
- Past Month Accomplishments in System Engineering, Instrumentation, Satellite, Launch Services, Science Data System and Mission Operations System
- Planned Activities for Next Month in Each Area Listed Above
- Top Ten Concerns, Complete with History of Each
- Resource Margin Status
- Facility Utilization Status
- Risk Management Report
- Schedule Reserve Status
- Update of the Master Schedule

CNES will provide information to LaRC for its responsibilities on a monthly basis, and LaRC will provide the project report to CNES for information.

12.2 COMMUNICATIONS

Effective communications is vital to the mission success. The following methods will be utilized to ensure appropriate and timely interchange.

- Technical Representatives from CNES, LaRC on-site at each other's facilities
- Telecons (weekly, monthly, as needed)
- Monitoring/Reporting (weekly, monthly, as needed)
- Focused Technical Interface Meetings (face-to-face) with partners on a regular basis and in combination with other reviews when possible
- Reviews
- E-mail
- Documentation: Formal & Informal
- Livelink server for various functions:
    - Document Library
    - Project Status

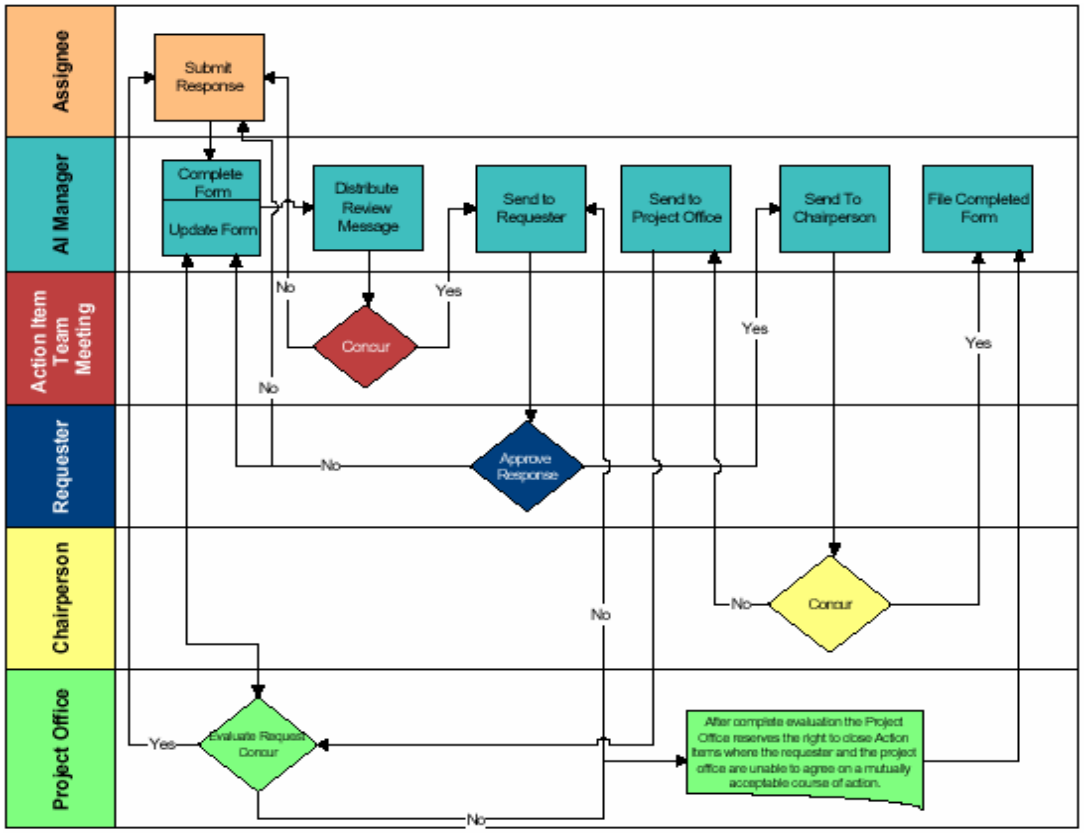
- News
- User's Subprojects
- Threaded Discussions

- Project Calendars
- Videocon Network Established

12.3 ACTION ITEM MANAGEMENT

The Action Item Closure process is defined in Figure 12-1. To summarize, each action item is assigned a unique number, an individual who is responsible for drafting the project's response, and a due date. The Information Manager tracks each action item to ensure timely response and closure. Once the response to the action is completed, the core CALIPSO management team meets to discuss the response and approve it prior to submittal to the requester for closure.

Figure 12-1 Action Item Closure Process



12.4 MISSION ASSURANCE

The Mission Assurance Management Plan (MAMP) (PC-PRJ-503) describes the mission assurance activities to be performed by NASA and CNES to ensure that the mission assurance objectives are met for the CALIPSO Project.

The CALIPSO project is organized into four segments: Ground, Launch, Satellite, and Science. Mission Assurance applies to all four segments. NASA, LaRC will exercise oversight of all segments' assurance planning and activity in concert with CNES' assurance representatives. The MAM is also responsible for Mission level Configuration Management (CM) and Risk Management in accordance with the separate CM and Risk Management Plans.

The MAM will ensure mission assurance activity within the following six functions: Quality Assurance, Failure Reporting, System Safety Management, Mission Reviews, Design Assurance, and Software Quality Assurance. Quality Assurance will include evaluation of transportation planning and operations.

12.5 SAFETY

Each mission system provider will generate their own Safety Plans that satisfy their unique internal requirements. An overall Safety Plan (PC-PRJ-505) will be generated by NASA and a Satellite Safety Plan will be generated by CNES to address all integration aspects as well as the types of safety features and mission level safety requirements that are levied upon all mission partners.

12.6 ENVIRONMENTAL IMPACT

Environmental Impact for the CALIPSO mission will address the environmental assessment performed in conjunction with the launch vehicle as well as the environmental assessment that is required due to putting a laser in space. The Environmental Impact Statement will address all aspects of using the instruments in space.

12.7 RISK MANAGEMENT

The CALIPSO Continuous Risk Management (CRM) Plan (PC-PRJ-504) defines the process and implementation of conducting CRM throughout the life-cycle of the CALIPSO mission. This document states that NASA and CNES will manage their risks in accordance with their respective procedures. Implementing CRM for the mission will provide a continual risk process (identify, analyze, plan, track, and control) for all disciplines and phases ensuring that communications and documentation are maintained across the entire mission and that informed decisions can be made on a timely basis. This CRM Plan is intended to complement overall CALIPSO Mission

Management and therefore CRM will be an integral part of project management. The implementation of this plan solicits inputs from everyone across the entire mission.

All project personnel are responsible for identifying, analyzing risks, planning mitigation strategies, and communication of the risk and its resolution. The project mission assurance personnel will perform the risk tracking and control functions.

12.8 SOFTWARE QUALITY ASSURANCE

The CALIPSO Software Quality Assurance Plan (PC-PRJ-513) establishes/defines the policies, standards, procedures, and practices for software assurance of all computer software for applications developed for the CALIPSO project. Software Quality Assurance applies to all software activities for the ground, launch, satellite, and science segments.

APPENDIX 1: FACILITIES AND LOGISTICS FACILITIES

In order for CNES and NASA to execute this Project, certain facilities, buildings, test complexes, ground stations, etc., are implicit and necessary to meeting the respective responsibilities. These facilities must be provided by each agency in accordance with the MOU. The lists of facilities provided below includes those owned directly by CNES, NASA, and/or its contractors and support agents that are available and are expected to be used for their intended purpose during the conduct of this Project.

For NASA, the facilities to be provided under the authority of the Project for the execution of CALIPSO are listed as:

Facilities	Activity	Agent	Location
Building/Offices	*Project Office*	NASA	Hampton, VA
Building/Laboratories			
Manufacturing	*Launch Vehicle*		
Complex	*Development*		
Launch Complex	*Satellite Launch*		
Tracking Station			

For CNES, the facilities to be provided under the authority of the Project for the execution of CALIPSO are listed as:

Building/Offices	Project Office	CNES	Toulouse
Building/Offices	Satellite Operations and Control	CNES	Toulouse
Building/Offices	Satellite contractor	ALCATEL	Cannes
Test facilities	Satellite contractor	ALCATEL	Cannes
Building/Offices	ISM contractor	SODERN	Limeil-Brevannes
Test facilities	ISM contractor	SODERN	Limeil-Brevannes
Tracking Station	Satellite Tracking	CNES	TBD

LOGISTICS

Regular telecons will be organized to facilitate direct contact between the various parties involved in the project.

APPENDIX 2: ACRONYMS

ABS	A-band spectrometer
AIT	assembly, integration, and test
ATBD	Algorithm Theoretical Basis Document
BOL	beginning of life
CDR	Critical Design Review
CNES	Centre National d'Etudes Spatiales
Co-PI	Co-Principal Investigator
COTS	commercial off the shelf
DAAC	Distributed Active Archive Center
DAO	Data Assimilation Office
DCN	Data Communication Network
DHU	data handling unit
DPM	Deputy Project Manager
EEE	electrical, electronic, and electromechanical
EEPROM	electrically erasable programmable read only memory
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EOL	end of life
EOS	Earth Observing System
EOS AM	Earth Observing System Anti Meridian
EOS PM	Earth Observing System Post Meridian
EOSDIS	Earth Observing System Data and Information System
ESSP	Earth System Science Pathfinder
FMEA	failure mode and effects analysis
FOV	field of view
FRR	Flight Readiness Review
FTP	file transfer protocol
GDIS	General Design and Interface Specification
GDS	ground and data systems
GPS	global positioning system
GSE	ground support equipment
GSFC	Goddard Space Flight Center
HDF	hierarchical data format
HU	Hampton University
I&T	integration and test
IASI	Infrared Atmospheric Sounding Interferometer
ICC	instrument control computer
ICD	interface control document
ICU	instrument control unit
IDL	interactive data language

IEEE	Institute of Electrical and Electronic Engineers
IFOV	instrument field of view
IIR	imaging infrared radiometer
IP	internet protocol
IPCC	Intergovernmental Panel on Climate Change
IPSL	Institut Pierre Simon Laplace
ISAP	International Science Advisory Panel
ISM	Infrared Sensor Module
LaRC	Langley Research Center
LITE	Lidar In-space Technology Experiment
LRR	Launch Readiness Review
M&P	materials and processes
MAM	Mission Assurance Manager
MCR	Mission Confirmation Review
MDRA	mission definition and requirements agreement
MOCC	Mission Operations Control Center
MOGS	Mission Operations Ground System
MODIS	Moderate-Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MRR	Mission Readiness Review
NEPA	National Environmental Protection Agency
NFR	Nonconformance/Failures Report
NRC	National Research Council
OMA	Office of Mission Assurance
PDDS	Payload Data Delivery System
PDR	Preliminary Design Review
PGGS	PROTEUS Generic Ground Segment
PI	Principal Investigator
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
P/L	payload
PM	Project Manager
POCC	Payload Operations Control Center
POLDER	Polarization and directionality of the Earth’s reflectance
PPRR	Payload PreShip Readiness Review
PROTEUS	Plateforme Reconfigurable pour l’Observation, les Telecommunications, et les Usages Scientifiques
SPRR	Satellite PreShip Readiness Review
SE	systems engineer
SER	systems engineering report
SOCC	satellite operations control center

SOGS	Satellite Operations Ground System
SRR	Systems requirements review
SSR	solid state recorder
STA	star tracker assembly
TBD	to be determined
TBR	to be reviewed
TOPEX/Poseidon	ocean topography experiment
TRR	Test Readiness Review
TTCET	Telemetry and Telecommand Earth Terminal
WBS	work breakdown structure
WFC	wide field camera

APPENDIX 3: MISSION INTEGRATED TEAM ORGANISATION

The main objective of the participation of CNES people on the team is to provide insight into the end-to-end system and have, at a single place, the capability to solve all the technical and programmatic problems related to the mission, by:

- Improving communications: provide same understanding of issues and solutions to NASA and CNES. The same access to information and tools is necessary to reach common understanding of the problems and for day-to-day work.
- Providing the capability to coordinate mission levels studies and planning (e.g. mission analysis and mission AIT) with the relevant people on both sides at the same location.
- Provide status of development (e.g. schedule, risk, issues, etc.)

1 MISSION INTEGRATED TEAM ORGANIZATION

The proposed mission integrated team is organized around the hierarchy of the product tree.

1.1 Mission Coordination

The mission level coordination is shown in Figure 1.

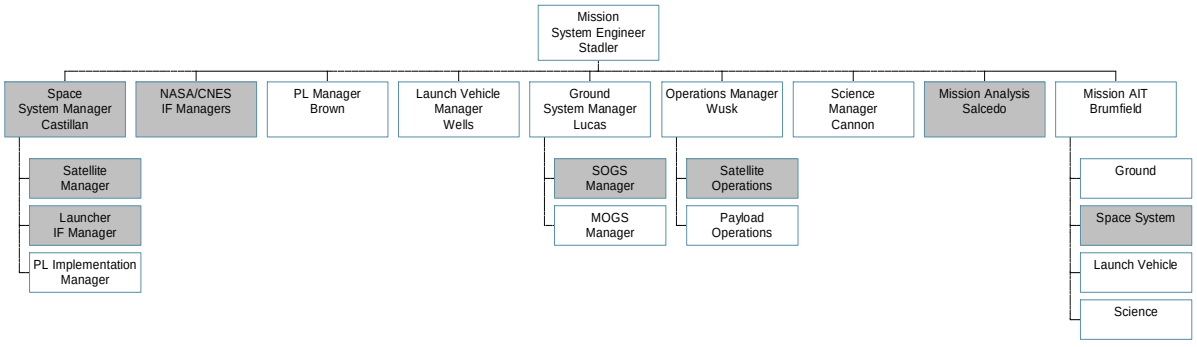


Figure 1 Mission level coordination, the Mission SE is responsible for coordinating mission level activities.

Comments:

- The mission integrated team consists of the segment leads, PL manager, NASA/CNES IF manager, and the Mission Systems engineering team.
- The Space System Manager leads the CNES participation to the Mission Integrated Team.
- The mission systems engineer is responsible for coordinating mission level activities (e.g. segment interfaces, mission design, mission AIT&V).

- The mission systems engineer (NASA) coordinates with the segment managers for all the mission level allocations, agreements, decisions ; he relies on the NASA and CNES Mission team members when needed.
- The mission systems engineer, as responsible of the development of the mission, is responsible of all the mission level studies, including when they involve the NASA or CNES Mission team members.
- Mission analysis (e.g. formation flying requirements, mission design, constellation coordination) activities:
    - LaRC is in charge of coordination with the other projects of the Afternoon Constellation.
    - CNES is in charge of the Calipso Mission Analysis
- Mission AIT is coordinated by LaRC.
- The NASA/CNES IF managers coordinate with the Satellite, Ground and Operations teams (i.e. facilitates the interactions between NASA and CNES team members) as described in the satellite integrated team proposal. The IF managers arrange meetings/telecons as necessary and help to ensure that communication between the US and French team members is clear. The NASA/CNES IF managers are located at Langley part time (7-10 days/month), and part time at CNES.

1.2 The NASA Mission team members include:

- Mission design
- Segment interfaces
- Mission AIT/AIV
- Performances (related to mission)
- Ground system lead
- Operations lead
- Science lead
- Launch vehicle lead

1.3 The CNES Mission team members include:

- Satellite lead
- Mission analysis

- Performances
- AIT/AIV
- Ground system
- Operations
- LV Interfaces

1.4 CNES Participation Summary

The NASA/CNES IFManagers work part-time at NASA Langley Research Center, part time at CNES.

CNES Mission Analysis occasionally works at NASA Langley Research Center.

CNES AIT manager occasionally works at NASA Langley Research Center.

Quarterly mission level TIMs

APPENDIX 4: SATELLITE INTEGRATED TEAM ORGANIZATION

CALIPSO SATELLITE INTEGRATED TEAM ORGANISATION AT TOULOUSE

The main objective of the participation of NASA/Ball people to the team is to have, at a single place, the capability to solve all the technical problems related to the satellite, particularly the implementation of the Payload on the satellite, by:

- Improving communications: same access to information and tools is necessary to reach common understanding of the problems; when people live together, they are obliged to solve disagreements in a timely manner, while when they are on both sides of the ocean, they can live a long time with diverging approaches, each side considering only its own approach as valid and applicable (e.g. mechanics!)
- Having at the same place the right people capable (alone or with the support of their respective teams) to reach decisions/agreements and make sure they are applied by their respective teams; by such, avoiding that the decisions/agreements of one day are denied the day after by some other project team members (clear assignment with delegation/responsibility)
- When needed, having at the same place the capability to perform satellite levels studies, with the relevant people on both sides, in the cases where Payload and Platform interact such that working at interface is not sufficient.

1 Integrated team Organisation

1.1 NASA CONTRIBUTION

The participation of NASA to the CNES team is:

1) A full time NASA engineer, appointed by NASA as "responsible of the implementation of the payload on the satellite" , with support of the NASA PL systems engineer at Ball:

- Responsible for PL interfaces, for PL budgets and satellite related performances, for NASA participation to satellite analyses -ex stability, Boresight mechanism design optimization-) ; responsible with respect to CNES for Payload qualification, procurement and AIT
- In NASA organization the PL implementation manager is in charge of these responsibilities, and has the capability to be supported directly, upon request, by LaRC and Ball engineers.

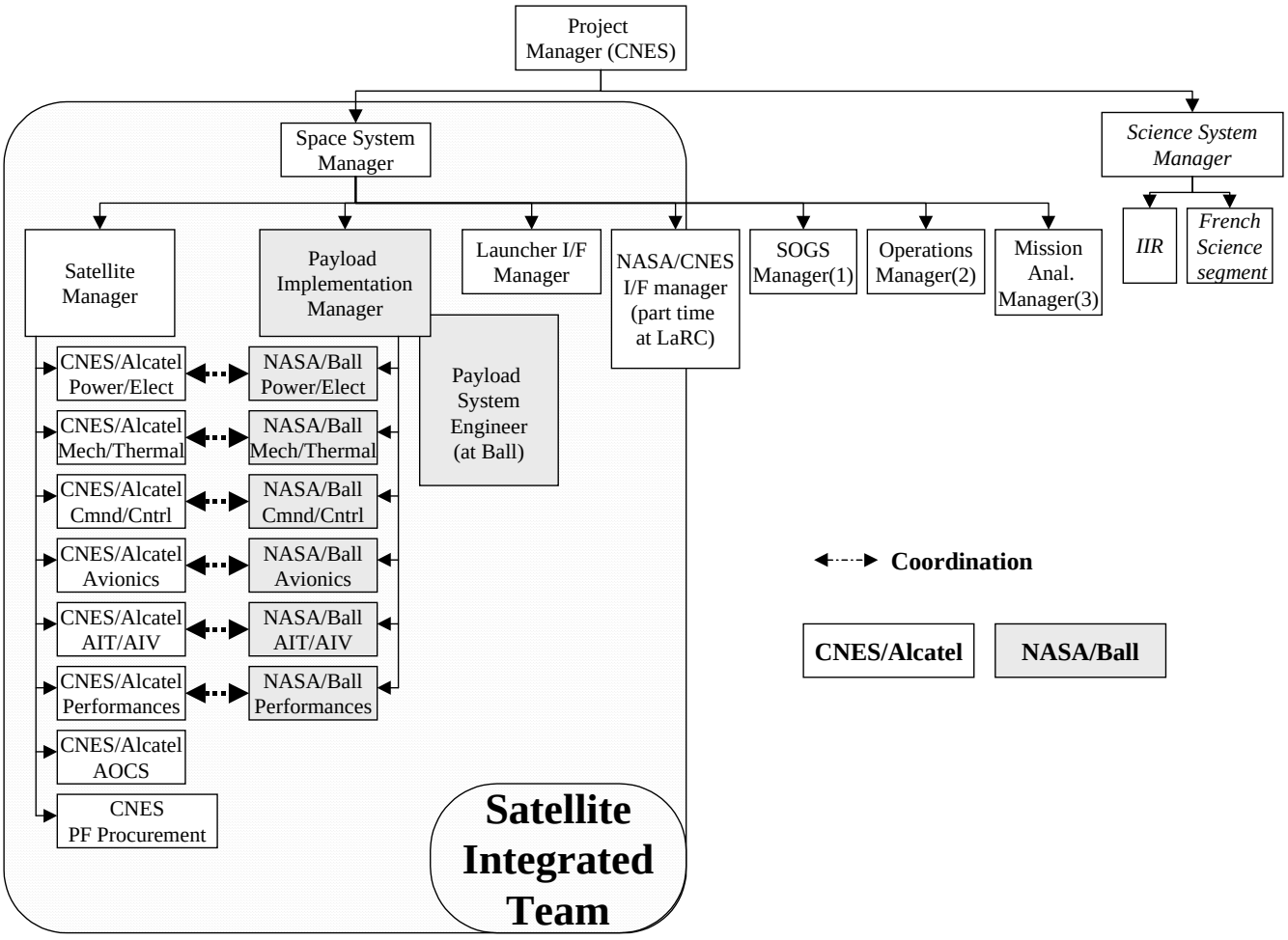
- He Coordinates with the space system lead in CNES and reports to NASA : PL implementation manager decisions/agreements commit NASA/Ball for his domain of responsibility (up to him to get right approvals).

2) Participation to common working sessions, with architects from both sides, quarterly and upon request.

3) A part time AIT engineer, starting approx. mid 02 for AIT/AIV preparation at Toulouse, then additional full time AIT engineer at Alcatel starting from Payload delivery (March 03).

1.2 SATELLITE INTEGRATED TEAM ORGANISATION

The Chart shows the SIT organization and its relationship with the CNES project organization



Comments:

- Space System manager (P.Castillan) is responsible in CNES for coordinating the work of the space System. Consequently, he is also responsible for coordinating the work of the Satellite Integrated Team ; he is, for NASA, the Satellite Segment Lead and, as such, is the interlocutor of NASA for satellite (and ground & operations)
- Payload Implementation Manager (A.Little) is full time in Toulouse; Payload AIT manager is part time in Toulouse till March 03 (start of sat AIT), then additional AIT engineer full time at Cannes ; NASA/Ball Architects are at Toulouse only during specific working sessions, quarterly and upon request.
- Payload Implementation Manager (NASA) reports to the Space System manager (Satellite Segment Lead) for all the allocations, agreements, decisions ; he relies on NASA/Ball architects when needed and the Space System manager relies on CNES/Alcatel architects when needed.
- The Satellite manager (J.Blouvac), as responsible of the development and the procurement of the satellite, is responsible of all the satellite level studies, including when they involve the NASA/Ball architects.
- NASA/CNES I/F manager (P.Ferrier) (CNES) is in charge of the PL/PF interface management (PDIS, PDP, deliveries, etc..) part time, and he resides part time (1 week/10 days per month) at LaRC for facilitating NASA/CNES communication on additional topics than satellite ones (SOGS, operations, System, IIR). He makes commitments for the Platform/Payload Interface related area.
- NASA Payload systems engineer (D.Rosenbaum)(at Ball) coordinates with the payload implementation manager for Ball support for payload development and interface issues.
- Launcher I/F manager is Joel Dejoie
- The CNES and Alcatel architects include, for platform and Satellite:
    - Power
    - AOCS
    - Mechanical & Thermal
    - Control-Command
    - Interfaces
    - AIT/AIV
    - Performances

- Platform procurement
- The NASA and Ball architects include, for Payload:
  - Power
  - Mechanical & Thermal
  - Payload / Platform interfaces
  - AIT/AIV
  - Performances (related to satellite, not instruments)

2 Phases/Schedule of implementation

The first phase of implementation is till the Mission CDR, in order to solve all the interfaces, ICD's & compatibility remaining issues, prepare and issue the ICD's.

The second phase is between Payload CDR/SMRR and payload delivery.

The third phase is the satellite AIT

The fourth phase is the launch campaign.

We will focus on the first short term phase.

2.1 TILL MISSION CDR

Objective: to solve all the interfaces, ICD's & compatibility remaining issues ; to issue the ICD's

2.2 FROM MISSION CDR TO PAYLOAD DELIVERY

The participation should be limited for the most part to the Payload Implementation Manager and the NASA PL systems engineer at Ball, with in addition some working sessions quarterly and when needed, and progressive involvement of the Payload AIT manager.

2.3 SATELLITE AIT

A payload integration team is approx full time at Cannes during Satellite AIT, under the leadership of the Payload AIT manager.

2.4 LAUNCH CAMPAIGN

A payload integration team and satellite integration team is approx full time at VAFB during LV AIT. The respective responsibilities are still to be discussed

CALIPSO SIT: Nomination of the technical responsibility

2.5 ROLES & ORGANIZATION:

- For each discipline (Mechanical & Thermal, Electrical, Command & Control, AIT, Satellite & Payload system), one CNES lead and a NASA co-lead are appointed.
  - Their area of responsibility includes and is limited to all the topics related to their discipline (applied to the satellite) as far as they don't interfere with "outside": in case they address issues that are beyond their area of responsibility (impacts on performances, on interfaces, on other disciplines, ...), or in case they don't reach solutions, or if they don't solve disagreements at their level, they are directed to report to the core team.
  - The lead is in charge to organize the actions relative to his discipline ; he commits for the satellite and the platform in the area of his discipline.
  - The co-lead coordinates with the lead for organization of work ; he commits for the payload in the area of his discipline.
  - The lead and co-lead, inside their field of responsibility:

    - are charged to organize the work, to reach decisions, to solve the problems.

    - they define the participants for studying the issues, they define the actions assignees, the meeting attendees.

    - they ask for necessary support in their respective organisations (NASA + BALL; CNES + ALCATEL).

    - they are directed to report the progress of their work and their decisions reached to the "core team" (see list hereafter).

    - they are directed to report to the core team in case of issues that are beyond their area of responsibility (impacts on performances, on interfaces, on other disciplines, ...), or in case they don't reach solutions, or if they don't solve disagreements at their level.
  - The CNES leads report to Patrick Castillan (relations with NASA, impacts on payload, mission level..) and to Jean Blouvac (relations with Alcatel, satellite engineering, impacts on platform,…)
  - The NASA co-leads report to Alan Little and to Kevin Brown (relations with Ball)

- For each discipline, the exchange of information (questions, data, etc...) between the two agencies are transmitted through the lead for CNES and the co-lead for NASA. The core team is in copy.

2.6 APOINTMENT:

- Mechanical & Thermal:

Lead	***Joel DEJOIE***	Phone number	***05.61.28.14.55***	Email address	***joel.dejoie@cnes.fr***
Co-lead	***Scott HILL***	Phone number	***757-864-7029***	Email address	***s.a.hill@larc.nasa.gov***

- Electrical :

Lead	***Pierre TASTET***	Phone number	***05.61.27.46.66***	Email address	***pierre.tastet@cnes.fr***
Co-lead	***Dave ROSENBAUM***	Phone number	***303-939-6603***	Email address	***d.m.rosenbaum@larc.nasa.gov***

- Command & control :

Lead	***Helene COTTET***	Phone number	***05.61.27.43.15***	Email address	***helene.cottet@cnes.fr***
Co-lead	***Mary-Beth WUSK***	Phone number	***757-864-3830***	Email address	***m.e.wusk@larc.nasa.gov***

- Avionics:

Lead	***Emmanuel Robert***	Phone number	***05.61.27.32.05***	Email address	***Emmanuel.robert@cnes.fr***
Co-lead	***Ron Verhappen***	Phone number	***757-864-2405***	Email address	***r.c.verhappen@larc.nasa.gov***

- Satellite & Payload system:

Lead	***Jean BLOUVAC***	Phone number	***05.61.28.27.82***	Email address	Jean.blouvac@cnes.fr
Co-lead	***Alan LITTLE***	Phone number	***757-864-1656*** ***05.61.27.33.09***	Email address	a.d.little@larc.nasa.gov ***alan.little@cnes.fr***

- Satellite A I T:

Lead	***Patrick Hozé***	Phone number		Email address	
Co-lead	***Larry BRUMFIELD***	Phone number	***757-864-3793***	Email address	***m.l.brumfield@larc.nasa.gov***

- Core team:

  - CNES: Patrick CASTILLAN, Jean BLOUVAC, Pierric FERRIER, Bruno BELON.

  - NASA: Kevin BROWN, Alan LITTLE, John STADLER, Mary Beth WUSK, Mike BLYTHE, Debbie DAJON, John ROGERS.

Table 1 Roles of SOGS, Satellite Ops and Mission Analysis Managers in the CNES Space System Team, and in the Mission Integrated team

	CNES Space System Team	Mission Integrated Team
SOGS Manager	Develop & assemble SOGS SOGS-Sat I/F	SOGS requirements vs Ground segment SOGS-MOGS I/F Participation to end to end tests
Satellite Operations Manager		
Mission Analysis Manager	Define strategy compliant with requirements Implement	Define formation Flying agreement with other missions → define Mission flying requirements

ANNEX C

NASA KSC / Analex Corporation

Expendable Launch Vehicle Integrated Services (ELVIS) Contract Statement of Work (SOW)

1.0 Safety

ANALEX shall perform systems safety assessments, procedure reviews, and operations surveillance of spacecraft contractor design, integration, and test activities to ensure the identification and assessment, and elimination, or control of hazards.

1.1 Systems Safety Assessments

ANALEX shall perform system safety assessment of mission unique design, integration, test activities, and launch preparations. ANALEX shall participate in the tailoring of applicable safety requirements. ANALEX shall review and provide assessment of Spacecraft and Expendable Launch Vehicle (ELV) Missile System Pre-launch Safety Packages (MSPSP) or equivalent documents, variance requests, and design changes.

1.2 Procedure Reviews

ANALEX shall review all integrated procedures classified as hazardous to ensure hazardous operations are identified and appropriate safety precautions are implemented. In both cases, ANALEX shall assess all non-hazardous procedures to ensure proper classification.

1.3 Safety Surveillance and Support of Operations

ANALEX shall perform safety surveillance and assessments of all hazardous operations for NASA and Non-NASA missions when processing takes place on NASA property or within a NASA facility. ANALEX shall perform safety surveillance of all NASA mission integration activities that are classified as hazardous and are being performed on Launch Service Provider (LSP) property or within a Launch Service Provider (LSP) facility.

1.4 Participation in Meetings, Reviews, and Working Groups

ANALEX shall participate in NASA, Launch Service Provider (LSP) and spacecraft contractor, meetings/reviews including, status meetings, Technical Interchange Meetings, Design Reviews, Phase Safety Reviews, Payload Safety Working Groups, and Ground Operation Working Groups for NASA missions and other processing operations in NASA's assigned facilities.

1.5 Safety Training

ANALEX shall develop and conduct safety training including all required facility access/safety training for all NASA customers, NASA transient/resident, and contractor personnel for each NASA mission.

1.6 Quality Surveillance of Launch Service Provider (LSP)

ANALEX shall provide surveillance at all manufacturing, processing, testing, and launch site locations. ANALEX shall participate in local reviews, meetings, pertinent tests and local site visits.

1.7 Design Reviews:

ANALEX shall participate in Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), and Design Certification Reviews (DCR), Mission Unique Requirements Reviews (MURR), Mission Unique Preliminary Design Reviews (MUPDR), and Mission Unique Critical Design Reviews (MUCDR). ANALEX shall review and provide technical assessment of Design restrictions, limitations and known violations including system safety, hardware and software.

1.8 Production Reviews

ANALEX shall participate in Hardware Acceptance Reviews (HAR), Pedigree Reviews, Production Reviews, and Pre-Vehicle-On-Stand Reviews (Pre-VOS). ANALEX shall review and provide technical assessments on any build paper, test results, non-conformance reports, discrepancy history, failure analysis, waivers, deviations, and MRB's presented at reviews.

1.9 NASA Launch Readiness Reviews

ANALEX shall attend Pre-Launch Readiness reviews (LRR and FRR) and launch activities.

2.0 Launch Site Support Engineering

ANALEX shall work with the NASA Launch Site Integration Manager (LSIM) for all ground processing mission activities and provide launch site support documentation, launch site operational services, launch operations management support, and launch site administrative services. The NASA Launch Site Integration Manager (LSIM) is the primary interface and ANALEX is the secondary interface. ANALEX shall represent the NASA Launch Site Integration Manager (LSIM) position at meetings, teleconferences, design reviews, technical interchange and working group meetings when the NASA Launch Site Integration Manager (LSIM) cannot attend.

ANALEX shall be the point of contact (POC) between spacecraft projects and other organizations including the Eastern Range (ER) and the Western Range (WR), Government/Commercial Payload Processing Facility (PPF)s, and Launch Service Provider (LSP)s.

2.1 Launch Site Documentation Services

ANALEX shall provide launch site documentation services.

ANALEX shall gather all documentation requirements from the payload customers by direct communication and through attendance to spacecraft and Launch Service Provider (LSP) meetings. ANALEX shall travel to the meetings if not held locally possibly involving foreign travel. These meetings include, but are not limited to the following: Project Kick-Off Meeting, Preliminary Design Review, Critical Design Review, Mission Integration Working Group meetings and teleconferences, Ground Operations Working Group meetings and teleconferences, Technical Interchange meetings, Pre-Ship review meetings. Launch Site Readiness Review, Flight Readiness Review, Launch Readiness Review. ANALEX shall use the information gathered and provide documentation services.

2.2 Launch Site Support Plan (LSSP)

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Launch Site Support Plan (LSSP). ANALEX shall publish and distribute preliminary and baseline versions of the Launch Site Support Plan (LSSP) with revisions as necessary. ANALEX shall catalog and incorporate changes to the Launch Site Support Plan (LSSP) and conduct detailed reviews with the payload customer in order to refine the document.

2.3 Program Introduction (PI) document for the Range

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Program Introduction (PI) document and submit to the Range.

2.4 Program Requirements Document (PRD) for the Range

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Program Requirements Document (PRD) for the Range.

2.5 Spacecraft Mission Operations Requirements (OR) document for the Range

ANALEX shall provide input to the Launch Service Provider (LSP) in the writing of the mission Operations Requirements (OR) document for submittal to the Range. ANALEX shall use the Launch Site Support Plan (LSSP) and Program Requirements Document (PRD) as well as further input from the NASA Launch Site Integration Manager (LSIM) and the payload customer to define and develop specific spacecraft inputs for the Launch Service Provider (LSP)-developed mission Operations Requirements (OR). ANALEX shall work closely with the Launch Service Provider (LSP) writer of the Operations Requirements (OR) to input these requirements. ANALEX shall review draft and published copies of the Operations Requirements (OR) for correctness. ANALEX shall modify Operations Requirements (OR) input as required.

ANALEX shall prepare the spacecraft Operations Requirements (OR) document for payloads processed in NASA and commercial Payload Processing Facilities (PPF). ANALEX shall use the Launch Site Support Plan (LSSP) and Program Requirements Document (PRD) as well as further input from the NASA Launch Site Integration Manager (LSIM) and the payload customer to develop a spacecraft-specific spacecraft Operations Requirements (OR) for spacecraft processing support in a Payload Processing Facility (PPF). ANALEX shall modify the spacecraft-specific spacecraft Operations Requirements (OR) as required.

2.6 Safety Advisory Function

ANALEX shall review customer requirements and advise the payload customer in safety planning including, but not limited to the following areas of facility requirements and modifications: mechanical, electrical, communications, contamination control, office space, telephones, base access and security.

ANALEX shall provide safety advice to the payload customer for the preparation the Missile Systems Pre-Launch Safety Package (MSPSP).

2.7 Review of Launch Service Provider (LSP)/Range-Provided Documentation

ANALEX shall review the Launch Service Provider (LSP) spacecraft Interface Control Document (ICD) and spacecraft questionnaire for completeness and accuracy of spacecraft requirements. ANALEX shall submit comments to the Launch Service Provider (LSP) after concurrence with the NASA Launch Site Integration Manager (LSIM).

ANALEX shall review and provide comments to the NASA Launch Site Integration Manager (LSIM) on Range-authored support documentation to ensure the Range properly addresses all customer requirements. This documentation shall include, but not be limited to the following:

- Statement of Capability (SC), which is the Range response to the Program Introduction (for Vandenberg Air Force Base (VAFB) missions only)
- Program Support Plan (PSP), which is the Range response to the Program Requirements Document
- Operations Directive (OD), which is the Range response to the Operations Requirements Document

- Network Implementation Plan (NIP), which is the Range launch day communications implementation plan
- Integrated Communications Requirements Document (ICRD), which is a communications annex to the Operations Requirements (OR) document

2.8 Launch Site Integration Operational Services

ANALEX shall perform the operational support tasks in coordination with the NASA Launch Site Integration Manager (LSIM).

2.9 Payload Transportation

ANALEX shall coordinate security escorts, and coordinate support from US Customs, Immigration and Agriculture Department for foreign payloads.

2.10 Payload Operations in the Payload Processing Facility (PPF)

ANALEX shall coordinate the review of payload customer test plans and technical operational procedures and track their approval status.

ANALEX shall perform the following tasks for payload operations in the NASA Payload Processing Facility (PPF)s:

- Distribute keys/combinations
- Coordinate facility and safety training
- Coordinate shipping and receiving services
- Coordinate access lists and guard orders
- Maintain a spacecraft activities log book
- Coordinate the procurement and use of consumables, supplies and materials
- Coordinate and schedule support for fueling operations
- Coordinate delivery radiation sources with the USAF
- Coordinate storage of pyros and radiation sources
- Coordinate photo support from the USAF
- Be cognizant of payload activities and reschedule support in response to anomalies and changes in plans

2.11 Payload Operations at the Launch Complex

ANALEX shall coordinate movement of payload ground support equipment (GSE).

ANALEX shall coordinate all launch complex access requirements including, but not limited to training, badging, security escort services, and tours.

ANALEX shall coordinate contractor support for off-shift operations, monitor payload activities, and reschedule support in response to anomalies and changes in plans.

2.12 Post Launch

ANALEX shall coordinate GSE movement, monitor customer clean-up/close-out activities, and coordinate shipping services.

3.0 Launch Operations Management Services

ANALEX shall provide launch operations management services in coordination with the NASA Launch Site Integration Manager (LSIM).

ANALEX shall coordinate between the Launch Service Provider (LSP), NASA Launch Director, NASA Launch Site Integration Manager (LSIM), and payload customer to produce the Launch Management Coordination Meeting (LMCM) presentation package. The Launch Management Coordination Meeting (LMCM) package shall include, but not be limited to launch day management and reporting structure; launch day "GO/NO GO" charts; list of mandatory assets for launch; launch day seating charts; launch day voice communication charts; and range conflict calendar.

ANALEX shall coordinate and schedule launch countdown rehearsals for the payload customer in the weeks prior to launch.

ANALEX shall, in coordination with the external public affairs organization, create and implement a plan to provide voice communications, video, timing, satellite up-links and down-links, and Launch Site Support Trailer (LSST) for coverage of a launch. ANALEX shall participate in planning meetings and teleconferences.

4.0 Launch Site Administrative and Customer Services

ANALEX shall provide secretariat function services for all launch site integration activities to include, but not be limited to the following: develop meeting minutes/actions and publish/distribute preliminary and final versions, prepare agendas and security access lists, coordinate meet-me numbers for teleconferences, arrange facility accommodations and presentation equipment, reproduce meeting materials, and record attendance

4.1 Launch Site Customer Services

ANALEX shall conduct the Launch Site Introduction/Familiarization Briefing for the payload customers. ANALEX shall prepare the briefing material to include but not be limited to familiarization/introduction of the launch site, list of points of contact, local community and center/base accommodations/capabilities, and any specific information related to facilities/equipment.

5.0 Mission Integration Coordination Services

ANALEX shall participate in each Expendable Launch Vehicle (ELV) mission through active participation of the Mission Integration Teams (MIT).

5.1 Integrated Mission Data, Documentation, and Schedules

ANALEX shall prepare a mission plan for each mission immediately preceding the Authority To Proceed (ATP) for the Launch Service Provider (LSP). The mission plan shall be accessible to payload customers through a controlled website.

Using inputs from the NASA Mission Integration Team (MIT), ANALEX shall prepare and maintain an integrated mission schedule that shall be compatible with Milestones Professional scheduling software. ANALEX shall evaluate mission integration schedules to identify potential schedule conflicts and inform NASA.

ANALEX shall maintain and NASA Payload Planner's Guide using information provided by the MIM.

5.2 Administrative Services

ANALEX shall develop documentation packages (e.g. Risk sheets, Mission Integration Working Group (MIWG) presentations) for mission management and NASA Mission Integration Team (MIT) activities to include, but not be limited to meetings, briefings, reviews and other activities that are at the Agency, Program, Project, and NASA Mission Integration Team (MIT) levels.

5.3 Secretariat Functions

ANALEX shall provide secretariat function services for all NASA Mission Integration Team (MIT) reviews to include, but not be limited to the following: develop meeting minutes/actions and publish/distribute, prepare agendas, coordinate meet-me numbers for teleconferences, arrange facility

6.0 Launch Engineering Team (LET) Services

ANALEX shall provide technical services to the Launch Engineering Team (LET) formed to support NASA and NASA-sponsored Expendable Launch Vehicle (ELV) launches to include, but not be limited to the following:

- Document, organize, and track internal and external action items that are significant to the LET in preparation for readiness reviews during the launch campaign such as Pre-Vehicle-On-Stand (Pre-VOS) Reviews, Systems Reviews, Flight Readiness Reviews (FRR), Launch Readiness Reviews (LRR), and related technical readiness reviews.
- Coordinate Technical Interchange Meetings (TIM) to include participation from offsite engineering organizations. Document, organize, and track internal and external action items that are relevant to the LET.

7.0 Communications and Telemetry

ANALEX shall provide engineering, operations, and maintenance of NASA communications and telemetry systems in all operational areas for NASA supported Expendable Launch Vehicle (ELV) missions including commercial and other payload customers of the NASA Program.

ANALEX shall provide technical interchange with NASA to provide status and immediately communicate any significant issues.

ANALEX shall be responsible for the following communications and telemetry support activities while processing at NASA and/or Commercial Payload Processing Facility (PPF)s:

- Operation & Maintenance of Communications and Telemetry Systems
- Disposition Requirements
- Engineering and Planning
- Setup and Activation
- Configuration Control
- Maintenance
- Troubleshooting
- Breakdown and Stowage

ANALEX shall provide troubleshooting and platform services for Expendable Launch Vehicle (ELV) customers where required. ANALEX shall coordinate and schedule customer requirements. ANALEX shall create a customer interface for data services to adapt customer equipment to the facility transport where necessary.

ANALEX shall permit specific equipment to remain operational and un-attended during non-supported hours when requested by NASA. ANALEX shall report to NASA the risks associated with unattended operation of this equipment and shall take appropriate steps to mitigate these risks.

7.1 Communications Systems

Using Installation-Provided Property (IPP), ANALEX shall provide the following services to all NASA customers:

- Voice
- Video
- Data
- Timing

ANALEX shall request and schedule communications circuits and support from the responsible organizations to meet all requirements. ANALEX shall coordinate directly with these outside organizations to assist in the activation and troubleshooting of these assets. ANALEX shall field support equipment to outfit these communications circuits to satisfy customer requirements.

ANALEX shall provide real-time end-to-end testing and troubleshooting of all communication links. ANALEX shall provide communication services for the public affairs video and audio production and satellite uplink activities for all NASA sponsored missions. This shall include all required planning of external contractor video and audio productions and technical support to interface equipment with NASA communication and video circuits.

7.2 Telemetry Systems

ANALEX shall provide time-tagged reception, recording, processing, and display of all incoming telemetry data. Telemetry data shall consist of: FM/FM telemetry, PCM/FM telemetry and separate analog signals. This data shall arrive via hard-line, fixed RF antenna, NASA Integrated Services Network (NISN), Internet-protocol Operational Network (IONET), or modem. ANALEX shall provide playback telemetry data support including displays and strip-charts as required by NASA.

ANALEX shall plan, develop, maintain, and troubleshoot software on the telemetry processing systems as required.

ANALEX shall provide analog recording and reproduction of unprocessed telemetry data and timing. ANALEX shall make copies of these tapes as requested by NASA and deliver them to the appropriate destination. ANALEX shall create and maintain a set of paper strip-chart recordings for all major tests and launch attempts, and copies of these recording will be delivered to the appropriate destination.

7.3 Upcoming Launches Scheduling, Planning, and Status Reporting

ANALEX shall create, maintain, and implement an integrated schedule for all the services provided for each scheduled mission.

ANALEX shall provide implementation plans for meeting mission communications and telemetry requirements including design drawings, procurement documentation, resource allocation, agreements with external service providers, and detailed scheduling.

ANALEX shall participate in technical interchange meetings to provide status to NASA and to receive customer requirements. ANALEX shall also conduct facility and console familiarization presentations to NASA customers.

ANALEX shall participate in launch readiness reviews and briefings and provide presentations during these reviews on facility and equipment readiness status. ANALEX shall provide readiness reports to responsible critical activity review boards and status including testing results, training, certification, hardware and software status, and procedures. Prior to each Flight Readiness Review (FRR) scheduled 5 days before launch, ANALEX shall provide to NASA a detailed status of all equipment and resources required for the launch. This launch status briefing shall include but not be limited to:

- Configuration of all support equipment
- Version identification of all software
- Identification of all technical leads
- Any issues/concerns which may impact launch support
- Brief summary of any equipment, resources, or services which shall be used for the "first time" to support a launch
- Brief review of any problems which impacted the last launch and the actions taken as a result of these problems
- A formal declaration of the capability to support from ANALEX or sub-contractor

7.4 Technical Points of Contact (POC)

For each mission, ANALEX shall have a single point of contact in the following areas:

- Telemetry operations,
- Real-Time data processing,
- Communications,
- RF Systems operations,
- Mission Operations Director,
- Data Impound Coordinator

These POCs shall be responsible for the following:

- Providing NASA status on contractor support for the mission,
- Coordinating operation of the service during major tests and launch attempts for the mission,
- Provide the post launch briefing for services provided for the launch,
- Provide the problem report and resolution for issues and concerns that affected mission support.

7.5 Facilities, Facility Systems, and Support Equipment

ANALEX shall operate and provide routine maintenance of all Installation-Provided Property (IPP). ANALEX shall operate lifting equipment such as cranes and hoists and perform proof-load testing. When required, ANALEX shall proof-load payload customer equipment. ANALEX shall document results and provide NASA access to data related to maintenance records, troubleshooting efforts, problem causes, and corrective actions taken, proof-test certificates, operational and test procedures, and test data records in accordance with DRD-1, Access to Contract Data, Maintenance Records.

ANALEX shall provide electrician services to include, but not be limited to troubleshooting, reconfiguration, modification, and general maintenance of facility electrical systems.

7.6 Maintenance Management

ANALEX shall identify and document immediately upon discovery all real time problems related to mission-critical and safety-critical facilities, systems, and equipment. ANALEX shall coordinate resolution with all affected parties, including other contractors, to ensure effective responses and to provide mitigation.

ANALEX may be required to provide maintenance and repair in cases where the USAF Base Civil Engineering (BCE) services where the USAF support cannot be obtained in a prompt manner.

8.0 Base Operations Services

8.1 Administrative Support

ANALEX shall provide reproduction services and operation and maintenance of reproduction equipment.

ANALEX shall provide United States Postal Service and Vandenberg Air Force Base (VAFB) internal mail pickup and delivery.

ANALEX shall obtain photo and video services from the USAF 30th Visual Flight and provide coordination to satisfy NASA personnel, customer, and contractor photo and video requirements.

8.2 Graphics Services

ANALEX shall provide computer and manual graphics (drafting). This shall include, but not be limited to facility and equipment illustrations, organization charts, certificates, photograph, guest badges, and guest bus placards.

8.3 Transportation Services

ANALEX shall manage transportation services to meet all operations requirements to include, but not limited to spacecraft servicing equipment on site.

8.4 Shipping and Receiving

ANALEX shall provide services to include shipping, receiving, packing and crating, pick up and delivery of supplies, materials, equipment, and flight hardware. ANALEX shall receive all mail, packages, and truck shipments, check for damage, and notify end user of its arrival. ANALEX shall provide shipment services including overnight and point-to-point package delivery.

8.5 Laboratory Services

ANALEX shall operate and maintain gas-sampling equipment and obtain gas samples from tube bank trailers and K-bottles and coordinate chemical analysis from USAF Chemical Laboratory.

8.6 Non-Destructive Evaluation (NDE) Services

ANALEX shall provide test and inspection services including in situ NDE. ANALEX shall provide a written report detailing inspection results.

ANALEX shall perform non-destructive evaluation of handling equipment after structural modification and proof-load testing. The dye penetrant inspections shall be in accordance with American Society for Testing and Materials Standard Practice for Liquid Penetrant Examination (ASTM E 1417-99). Personnel performing the evaluation shall be trained in accordance with American Society for Nondestructive Testing (ASNT) documents ASNT CP-189-1991 “Standard for Qualification and Certification of Nondestructive Testing Personnel” and SNT-TC-1A “Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing.”

8.7 Security Services

ANALEX shall manage all necessary services and equipment needed for security, access permits/badges, and locksmith services.

8.8 Permits and Badges

ANALEX shall provide area access permits/badges for temporarily assigned payload customers and other visiting personnel for access to payload or flight hardware processing areas.

ANALEX shall maintain records of badges issued and account for the non-issued badge stock. ANALEX shall assure that any person being issued an access badge has received the appropriate Safety training required for the corresponding location to be visited.

ANALEX shall provide controlled area permits/badges/entry authorization lists, when required by customer projects within NASA facilities assigned to ANALEX or sub-contractor. ANALEX shall verify that personnel obtaining permits, badges, or inclusion on an entry authorization list meet the requirements for unescorted access within the controlled area.

ANALEX shall provide badge requests for contractor personnel for access to USAF restricted areas.

8.9 Lock and Key Control

ANALEX shall provide lock and key control including periodic inventory of keys in the NASA/Vandenberg Air Force Base (VAFB) master key system, posting classified document containers, changing lock combinations, and maintaining key control records, for facilities where ANALEX has operations and maintenance management responsibility.

8.10 Security Inspections

ANALEX shall provide end-of-workday securing inspections for all NASA-assigned facilities, and log all security inspection efforts.

8.11 Guest Services

ANALEX shall receive/screen requests for visits and process/maintain records of visit requests and authorization letters. ANALEX shall coordinate with entry control personnel in accordance with USAF regulations to assure proper credentials are ready when the visitor arrives. ANALEX shall be prepared to resolve and expedite entry control problems with security officials.

ANALEX shall operate and maintain a system to provide foreign national escort services in support of payload operating schedules. ANALEX shall be responsible for providing continuous escorting and transportation services for foreign national visitors while on USAF/NASA property.

ANALEX shall develop and maintain visitor control lists as required for access to specific areas controlled by USAF and other contractors. ANALEX shall input data into the Visiting Personnel Security Database to include visiting personnel and their facility entry authorization at any given time.

9.0 Mission-Direct Support at Vandenberg Air Force Base (VAFB)

9.1 Payload Support

ANALEX shall provide transportation services for spacecraft and flight hardware to the Payload Processing Facility (PPF)s at arrival.

ANALEX shall provide transportation and setup services for support equipment including the Launch Site Support Trailer. ANALEX shall coordinate transportation and setup services with Communications and Telemetry personnel.

ANALEX shall operate, maintain, and setup the Spacecraft Close-out Shelter (SCS).

9.2 Clean-Room Services and Cleanliness Requirements

ANALEX shall prepare a Facility Contamination Control Plan. ANALEX shall ensure that all Clean Rooms and clean work area facilities and associated support equipment meet payload customer cleanliness requirements. ANALEX shall manage all clean room operations to assure customers follow all established contamination control procedures.

ANALEX shall provide assistance to customers in cleaning equipment prior to moving it into the clean room.

ANALEX shall operate and maintain clean room particle counting equipment.

ANALEX shall implement customer-produced contamination control plans. In the event the customer does not have a written contamination control plan, ANALEX shall coordinate/implement contamination control requirements with the customer.

9.3 Propellant Services

ANALEX shall coordinate requirements for propellant handlers ensembles with the USAF and the USAF protective equipment maintenance and operations contractor. ANALEX shall manage the scheduling of self-contained apparatus protective ensemble (SCAPE) and other propellant handlers protective equipment training for customers.

ANALEX shall coordinate the pre-operations and post-operations servicing of spacecraft fueling equipment.

9.4 Environmental Compliance

ANALEX shall ensure that NASA operations are compliant with all applicable federal, state, county, NASA, USAF environmental rules, regulations, and management plans. ANALEX shall maintain an environmental management program that closely interfaces with NASA and the USAF environmental management efforts. ANALEX shall act as the technical point-of-contact

(POC) and maintain a cooperative working relationship with USAF who has overall environmental compliance responsibility over all.

ANALEX shall represent NASA position in environmental meetings/working groups and provide to NASA evaluations/recommendations about the USAF position.

ANALEX shall provide environmental services to NASA for environmental programs. Services include technical regulatory consultation for interface with regulatory agencies; inspection of regulated facilities and systems; preparation of permits, reports, and other regulatory documents; and development and review of environmental documentation.

9.5 ANALEX shall provide environmental services to NASA operations including:

- Written evaluation and assessment of projects for requirements of the National Environmental Policy Act (NEPA).
- Preparation of NEPA documentation, e.g., Environmental Assessments, Environmental Impact Statements.
- Written evaluation of processes to determine permitting requirements and preparation of permit applications when identified.
- Ensure environmental permits are current and operations are in compliance with permit requirements. Written recommendations for corrective action to correct non-compliances.
- Preparation and delivery of reports to meet regulatory deadlines, e.g., permit compliance reports, Emergency Planning and Community Right-to-Know Act (EPCRA) reports, Toxic Release Inventory (TRI) reports, etc.
- Inspection of regulated facilities and systems for compliance in all media areas. Written recommendations and track corrective action for identified non-compliances.

ANALEX shall be responsible for management of hazardous materials throughout their life cycle – procurement, usage, and disposal. They shall:

- Obtain approval from USAF for use of hazardous materials.
- Maintain records of storage and usage for emergency management purposes and EPCRA and TRI reporting.
- Maintain material safety data sheets (MSDS) for hazardous materials used and/or ensure that MSDS are given to central location.
- Ensure safe storage and use of hazardous materials including development of operational procedures for storage, use, and disposal.
- Control, package, and process hazardous and controlled wastes generated during NASA operations in accordance with Federal, state and local procedures and regulations.
- Provide training to NASA personnel, contractors, and customers concerning the handling and use of hazardous materials and wastes to meet Federal, state, and local training requirements. Maintain the training records in a manner compliant with Federal, state, and local requirements.

10.0 Guard Services at Vandenberg Air Force Base (VAFB)

ANALEX shall provide for continuous (24 hours) guard services for NASA-sponsored payloads while processing in a NASA Payload Processing Facility (PPF) per each access entry at all times. ANALEX shall use authorized access lists and post orders detailing a minimum of tasks to be done to meet security requirements and exercise an emergency call tree.

11.0 Access Control Monitors (ACM) at Vandenberg Air Force Base (VAFB)

ANALEX shall provide trained personnel to perform as Access Control Monitors (ACM) continuously (24 hours) as rquired. Access Control Monitors (ACM) shall be responsible for monitoring personnel

limits in the facility, enforcing safety constraints, logging facility anomalies, contacting appropriate people in response to an anomalous condition, and operating the video and communications systems within the Hazardous Processing Facility. The Access Control Monitors (ACM) shall not perform as a security guard. In the event of an anomalous occurrence, the established call tree shall be exercised.

12.0 Satellite Uplink Services for NASA Public Affairs Support

For Vandenberg Air Force Base (VAFB) missions, ANALEX shall provide mobile satellite uplink services for a NASA sponsored mission to support mission-direct activities including an end-to-end communications test prior to launch day and/or a launch attempt.

13.0 Vehicle Engineering And Analysis

ANALEX shall perform engineering and analyses for the NASA Program. ANALEX shall review and evaluate Launch Service Provider (Launch Service Provider (LSP)) tasks and products delivered as part of each expendable launch vehicle launch service so that the NASA Vehicle Engineering Division can provide approval of mission unique items and a knowledgeable “go/no-go” for NASA missions.

As required, ANALEX shall prepare and deliver technical briefings to spacecraft and launch vehicle external review teams.

ANALEX shall have the ability to investigate and evaluate the design, modification, development, and implementation of all launch vehicle systems, ground support systems and equipment at all Expendable Launch Vehicle (ELV) and payload processing facilities and launch complexes used to provide Expendable Launch Vehicle (ELV) launch services to NASA. ANALEX shall review, evaluate and provide an assessment of launch vehicle systems where NASA identifies a requirement for technical insight into the development, design, manufacturing, testing, integration, and launch of the affected systems and launch vehicle.

ANALEX shall participate in Launch Service Provider (LSP) run reviews and payload customer reviews, which are chaired by NASA personnel, in order to provide technical evaluations and recommendations of the designs, analyses, manufacturing methods, tests, and operations presented at those technical meetings. The meetings include technical interchange meetings (TIM), mission integration working groups (Mission Integration Working Group (MIWG)), preliminary design reviews (PDR), critical design reviews (CDR), design certification reviews (DCR), Quarterly Program Reviews (QPR), Payload Planning Meetings, Payload Ground Operations Working Group (GOWG), Safety Review Meetings, Flight Readiness and Launch Readiness Reviews.

ANALEX shall review, evaluate, and provide technical assessment of all required Launch Service Provider (LSP) documents delivered as part of the integration of each Expendable Launch Vehicle (ELV) mission so NASA can approve items specified in the launch service contracts (e.g., Contract Data Requirements List (CDRL), Mission Integration Working Group (MIWG) minutes and action items). ANALEX shall be well versed in analyses methodologies used by all NASA Launch Service Provider (LSP)s. For assessments of Launch Service Provider (LSP) Contract Data Requirements List (CDRL), ANALEX shall provide a written report to the NASA Mission Integration Team to include a summary of the Contract Data Requirements List (CDRL) reviewed, rationale for agreement or disagreement, ground rules used for any contractor analysis performed, results and sound explanation which corroborate contractor analytic results, final conclusions and recommendations, and appropriate identification of risk and risk rating. At a minimum, ANALEX shall identify all significant issues that could potentially impact mission success, schedule milestones, or cost for NASA resolution with the Launch Service Provider (LSP).

Throughout the life cycle of each NASA mission, from identification of mission requirements until completion of post-launch data review, ANALEX shall gather data from Launch Service Provider (LSP)s

and spacecraft customers as well as perform their own independent research. ANALEX shall evaluate and assess mission specific launch vehicle systems, mechanical and electrical interfaces, mission-specific software, predicted spacecraft environments, and Launch Service Provider (LSP) actions for NASA missions. . Contractor technical assessments shall be provided to NASA for NASA resolution with the Launch Service Provider (LSP).

Throughout the build cycle for each NASA launch vehicle, from design requirements development until completion of post-launch data review, ANALEX shall participate in NASA and Launch Service Provider (LSP) technical activities and take all other steps necessary to maintain a knowledge base adequate to ensure prompt, accurate and complete evaluation of all flight and ground system technical issues or anomalies effecting NASA missions. The assessments shall include documentation of discrepancies, dispositions and corrective action plans. This requires knowledge for all Expendable Launch Vehicle (ELV) systems utilized by the NASA Launch Services Program Office, including knowledge of specific vehicles assigned to NASA and to non-NASA missions. .

ANALEX shall gather data, review telemetry, research requirements, review as-built documentation and as-run procedures, and perform any other investigative steps necessary to prepare and present evaluations to NASA-chaired Failure Review Board (FRB) meetings in the event of a failed mission. Evaluations of anomalies shall be presented to the Kennedy Space Center (KSC) Engineering Review Board. ANALEX shall evaluate the failed or anomalous systems in order to aid the determination of root cause so that NASA can direct or approve Launch Service Provider (LSP) corrective action plans and/or return-to-flight activities.

14.0 Mission Analysis

ANALEX shall provide rapid, accurate, and complete assessments of analytical items throughout the life cycle for each NASA mission and build cycle for each NASA vehicle. ANALEX shall perform reviews of Launch Service Provider (LSP) provided documents in order to ensure prompt technical assessments of all relevant issues that arise during the integration process. Evaluation of these issues may require ANALEX to perform an independent analysis in order to verify or better understand the Launch Service Provider (LSP) data. Documentation of evaluations and recommendations to NASA shall be such that NASA approval of analyses and/or direction to the Launch Service Provider (LSP) for corrective actions can be accomplished. The analytical areas that shall be covered include the following:

- Loads and Structural Dynamics
- Dynamic Environments
- Stress
- Flight Design
- Flight Software
- Controls and Stability
- Thermal/Thermodynamics
- Electromagnetic Compatibility
- CFD/Aerodynamics

ANALEX shall evaluate Launch Service Provider (LSP) analyses for compliance with applicable mission and vehicle requirements for each of the disciplines listed above so that the NASA Vehicle Engineering Division can provide prompt approval of mission unique items and a knowledgeable “go/no go” for NASA missions. ANALEX shall evaluate and provide technical assessments to NASA of the relevant Launch Service Provider (LSP) Contract Data Requirements List (CDRL), vehicle system design, testing (such as that required for flight software or environments), robustness in the areas of performance and reliability, and post flight data.

For all of the disciplines listed above, specific technical expertise required by ANALEX shall include the ability to:

- Develop and create complex vehicle models
- Simulate these models using relevant code
- Modify or update analytical code as required
- Understand the Launch Service Provider (LSP) tools and models such that input and output files can be reviewed efficiently and accurately.
- Review incoming reports and perform analytical checks as required

15.0 Vehicle Systems Engineering

ANALEX shall provide rapid, accurate, complete assessment of vehicle systems issues and provide notification to the NASA Vehicle Systems Lead and the NASA Chief Engineer in accordance with the Engineering Review Process. ANALEX is responsible for reviewing and evaluating Launch Service Provider (LSP) tasks and products so the NASA Vehicle Engineering Division can provide prompt approval of mission unique items and a knowledgeable "go/no-go" for NASA missions. ANALEX or sub-contractor's vehicle systems engineers shall evaluate and provide technical assessments of the Launch Service Provider (LSP) launch vehicle systems design, analyses, manufacturing, verification, validation, assembly, integration, testing, checkout, and launch preparations for compliance with applicable requirements and robustness in the areas of performance, safety, reliability, and quality.

ANALEX shall provide expertise in the following areas:

- Electrical/Avionics Engineering: electrical wiring avionics boxes, guidance and control systems, vehicle instrumentation, vehicle telemetry, vehicle Radio Frequency (RF) systems vehicle power systems, data acquisition/handling systems and Ground Launch Control Software, and electrical ground support equipment.

- Mechanical/Structural Engineering: structures, composite materials, payload adapters, mechanical separation systems, pneumatics systems, hydraulics systems, liquid and solid propulsion systems, ordnance systems, and contamination control methods.

16.0 Electrical/Avionics Engineering

ANALEX shall assess flight and ground Expendable Launch Vehicle (ELV) electrical and avionics systems for NASA's determination of their readiness for launch.

ANALEX shall assess mission unique requirements imposed on the design, modification, development, implementation, and flight performance of all electrical and avionics systems.

ANALEX shall participate in, and assess launch vehicle processing, payload integration and testing activities at both the launch site and at payload customer facilities (e.g., fit-checks) to verify overall Launch Service Provider (LSP) compliance with test procedures and acceptability of test results

17.0 Mechanical/Propulsion Engineering

ANALEX shall assess flight and ground Expendable Launch Vehicle (ELV) mechanical and structural systems for NASA's determination of their readiness for launch. ANALEX shall determine failure trends of components and investigate latent defects.

ANALEX shall review and assess mission unique requirements imposed on the design, modification, development, implementation, and flight performance of all mechanical and structural systems.

ANALEX shall participate in and assess launch vehicle processing, payload integration and testing activities at both the launch site and the payload customer facilities (e.g., fit-checks, environmental testing, payload shock testing) to verify overall Launch Service Provider (LSP) compliance with test procedures and acceptability of test results. In addition, ANALEX shall evaluate and make recommendations on payload mechanical compatibility drawings for human access verification.

ANALEX shall participate in and assess Launch Service Provider (LSP) plans to comply with mission cleanliness requirements in processing facilities, during transportation and payload/Expendable Launch Vehicle (ELV) integration, and under fairing environments. ANALEX shall provide expertise in materials utilization/compatibility with mission unique requirements according to contamination control plans.

18.0 Electronic Drafting

ANALEX shall provide electronic drafting capability to create, design and maintain 2-dimensional (2D) and 3-dimensional (3D) drawings.

ANALEX shall develop and maintain diagrams, schematics, modeling for accessibility and/or feasibility assessments for mission integration requirements and launch vehicle systems. ANALEX shall provide diagrams, schematics and modeling studies as part of the Engineering Review Process and the Mission Integration activities. Results to be supplied on hard copy and electronically to NASA.

EXHIBIT 2

Supporting Technical Data
on
ALCATEL Corporation

PROTEUS Multi-Mission Platform

Orbit	Every altitude between 500 and 1500 km. Orbital inclination above 15°.
Launcher	Compatible with every launcher which has a 1.9 m diameter fairing.
Mass	Maximum platform dry mass 270kg. Hydrazin capacity 28 kg. Payload Mass between 100 and 300 kg.
Reliability	0.875 for the 3 first years. 0.749 for the rest of the 5 years.
Life duration	between 3 and 5 years according to the chosen orbit.
Pointing	Standard 0.05° for each axis.
Power	Platform maximum consumption 300 W. Payload consumption class 200 W. Up to 300 W on some orbits.
Data storage	2 Gbits for the payload
Download link	727 kbits/s

Upload link	4 kbits/s
Downtime	0.88 %

The Proteus spacecraft bus is the basic module accommodating the housekeeping instruments required for the satellite to function, as well as the dedicated mission instruments. Proteus has been developed by Cnes to adapt to different minisatellites, thus cutting mission design costs.

The generic Proteus bus, developed in partnership by Cnes and Alcatel Space Industries, was used for the first time by the NASA launched Jason-1. The generic Proteus ground segment (control center and ground station) was also specially adapted for Jason-1.

End-to-End Space Systems

Alcatel Space program portfolio includes all kind of space systems and applications, in Telecommunications, Navigation and Localization, Observation/Science, Meteorology.

European leader in space-based systems, with prime responsibility for four complete systems :
- the WorldSpace satellite digital radio system
- the Syracuse military communications system
- Europe*Star for civil communications
- Egnos for satellite navigation

Leading supplier of space systems to the French ministry of defense, for example as prime contractor on the new-generation Syracuse III system.

Comprehensive turnkey solutions
From equipment and systems to services, Alcatel Space provides full support for our customers'own marketing, system architecture design, financing, frequency regulations, legal questions, and other organizational and governmental aspects.
We have already provided products and services for a number of major programs, including SkyBridge, Eurasiasat, Europe*Star, Agrani, Rascom, AirTV, etc.

Space and telecommunications technologies are an excellent fit. Today, satellite transmission capacity gives players in the telecom market an array of cost-effective, profitable solutions.
Alcatel Space works hand in hand with parent company Alcatel to offer customers unrivaled expertise in both telecommunications and space, including all-important standards, regulatory and market analysis aspects.

New Services :
- **DVB-RCS (A 97 80)**

Alcatel Space is involved in strategic partnerships of two-way satellite based systems using broadband technology (in Ku and Ka band frequencies) based on the DVB-RCS standard and targeting the Enterprise market, professional users such as corporations and small and medium-sized companies.
In this domain, Alcatel Space, working with industrial partners which are already committed to the development of DVB-RCS subsystems, is working on the development of the systems and will supply gateway and terminal products.
Documentation: http://www.alcatel.com/space/pdf/telecom/a9780gb.pdf (1.61MB)

- **DAB**

In the digital radio domain, Alcatel Space, is the European pioneer in the development of satellite radio systems, through hybrid satellite and terrestrial transmission systems for digital radio programs and associated telematics data in cooperation with partners such as operators and industries.
The aim is to provide :
- reception both in urban zones and in rural and suburban areas,
- reception of a large range of radio stations with digital quality, at home, at the office or in the car, without the need to change the dial while traveling,
- new musical and thematic channels,
- up to the minute news programs in multiple languages broadcast throughout Europe,
- ability to select radio programs 'on demand',
- additional benefits of receiving telematics data services while driving in the covered area.

Documentation: http://www.alcatel.com/space/pdf/telecom/dabgb.pdf (285 KB)

- **GMES**

Alcatel Space is also involved in major European programs such as Galileo and GMES (Global Monitoring for Environment and Security)
Documentation: http://www.alcatel.com/space/pdf/observation/gmes_gb.pdf (434 KB)

Ground Systems

Alcatel Space is one of the leading European companies for ground activities
Its expertise extends from the delivery of complete ground systems providing customized services, the design and development of equipments and products making up these systems up to the maintenance and the operations of such systems.
Alcatel Space employs nearly 1000 people dedicated to ground activities located in the company's French facilities as well as European subsidiaries.

Alcatel Space is the European leader in the contractorship for civil and military ground systems and segments
Its expertise in program management, system engineering, integration and validation, along with management of large international teams has led Alcatel Space to be responsible of the most important European ground systems such as :
- Envisat PDS,
- Egnos,
- Worldspace,
- Europe*Star,
- Syracuse,
- Meteosat,
- EPS (Eumetsat Polar System).

A recognized expertise
Alcatel Space has developed a recognized expertise for :
- Control segment (TT&C stations, satellite control centre for GEO and LEO satellites),
- Mission segment (In Orbit Test, Communication System Monitoring, simulators),
- Access segment (up-link stations, VSAT type individual stations, shared hub stations),
- Business segment (channel rental contracts management, invoicing, ressources allocation)
- Infrastructure segment (wide range of antennae of all sizes).

European leader in Operations
In addition, Alcatel Space is the European leader in Operations, starting with operations engineering (elaboration of operational procedures, controlers training, ground system operational qualification) up to the implementation of operations and maintenance.
Alcatel Space teams are today managing operations and providing controlers teams :
- at CNES Toulouse facilities for Spot, Telecom, S-Band network,
- at the Kourou launch facility where Alcatel Space has been in charge of operations for more than 30 years,
- at ARIANESPACE Evry and Kourou,
- at ESA/ESOC for the operations of the multi mission control system,
- and also at ESA/ESTEC, DLR/GSOC, TESAM, EUROPE*STAR.

Satellites

From GEO to LEO or specific missions, Alcatel can supply complete satellites, based on different in-house platforms supporting various payloads corresponding to missions as well as for telecommunications, observation, meteorology, navigation and science.

In the telecommunication domain, Alcatel Space offers increasingly powerful satellites - up to and exceeding 5,000 kg, with over 13 kW end-of-life power - featuring greater operational flexibility, proven reliability and extended life.

Alcatel Space is one of the world's leading space telecom players, with orders from the United States, Russia, Latin America, Africa and the Middle East, and growing business with Asian customers, especially China.

Space Platforms

SPACEBUS : one of the most advanced telecommunication satellite platform
The Spacebus product line constitutes a unique combination of performances and maturity that has established Alcatel Space's worldwide reputation
as a prime contractor and as a high quality manufacturer, of highly reliable satellites.
Spacebus: http://www.alcatel.com/space/pdf/activities/spacebus.zip (2.97 MB)
Avionics 4000: http://www.alcatel.com/space/pdf/technos/avionics.pdf (298 KB)

PROTEUS : a multimission platform for low orbit satellites
Fields of application : Science, Earth Observation, Navigation, Telecommunications, Environment... or your specific application.

PROTEUS offers :
- a generic service module designed and qualified for your needs
- a payload module adaptable to your application
- integration and testing of complete satellite
- ground software
- launch campaign
- in-flight reception
- delivery in less than 24 months, at a very competitive price.

The first application, Jason-1 (http://www.alcatel.com/space/programmes/observ_index.htm#jason) , dedicated to climatology, is operational in orbit (launched in Dec 2001)
Documentation: http://www.alcatel.com/space/pdf/activities/proteusgb.pdf (476 KB)

METEOSAT : a meteo dedicated platform for a spinned geostationnary satellite
- 7 of the first generation (700 kgs satellite)
- and 3 of the second generation (2 T satellite)

Documentation: http://www.alcatel.com/space/pdf/meteo/msggb.pdf (574 KB)

Space Payloads

Alcatel Space is the world's leading supplier of spaceborne telecommunications payloads :
We hold 25 to 30% of the world market, with over 130 payloads ordered.

Telecommunications
We cover the full spectrum of telecommunication application domains :
- Direct TV,
- multimedia,
- digital audio broadcasting,
- telecommunication and data transmission,
- and navigation payloads (associated to telecom satellites).

Observation
In the Observation domain, Alcatel Space provides different types of optical payloads for earth observation :
- High radiometric resolution such as Meris on Envisat and Vegetation 2 on Spot 5,
- High geometric applications : military such as Helios I and II and civilian such as Pleiades,
- But also different types of Radars : imagers such as ASAR on Envisat, a Synthetic Aperture Radar, or altimeters such as Poseïdon 2 the altimeter for Jason-1.

Sciences
Alcatel Space provides also various payloads in the scientific domain :
- Telescopes for space astronomy observation such as ISO and Corot,
- Specific payloads such as GOCE (on Gravity satellite) which accelerometers will allow to improve earth gravity field knowledge.

Instruments & Other Satellite Equipment And Services

More than 40 years of equipment history.

- Design
- Manufacture
- Integration and tests
- Sales

Observation Satellites

Alcatel Space is the European leader for high resolution space-based optical instruments and earth observation, meteorological and navigation ground segments

Alcatel Space is the world leader in geostationary meteo satellites and altimetry instruments

Alcatel Space is the first company in Europe to have mastered space-based observation instruments in the entire range of wavelengths : visible, radar (or microwave), infra-red, ultraviolet.

Alcatel Space is particularly involved in military observation programmes.

Alcatel Space is also involved in the major future European programs GMES (Global Monitoring for Environment and Security)
GMES, the both European Union and European Space Agency initiative which started in 1998, aims the statesmen to have the operational means which will allow to get worldwide regional or local environmental and security informations.
Alcatel Space offers its expertise and its innovative and attractive solutions in the telecommication domains , as well as for Science and Observation, meteorologie , terrestrial maritime and aeronautical navigation, forecast ,prevention and crisis management (natural diseases…) and robust and adapted informations transmissions.
Alcatel Space is involved in observation programs dealing with all the various thematics, (oceanography, climatology, meteorology or environment watch..) which are are the main components of GMES
In addition, Alcatel Group , world leader in telecommunication solutions and sytems integration has proven expertise in all areas contributing to the development of GMES architecture.
Documentation: http://www.alcatel.com/space/pdf/observation/gmes_gb.pdf (434 KB)

Among others, the 2 following examples illustrate Alcatel Space involvement in the GMES initiative : ROSES (http://www.alcatel.com/space/obs/obssystems.htm#roses) and SISA (http://www.alcatel.com/space/obs/obssystems.htm#sisa).

Systems

ROSES
The ROSES project (ROSES standing for **R**eal-Time **O**cean **S**ervices for **E**nvironment and **S**ecurity) started at the beginning of March 2003 in the framework of the ESA Earthwatch - GMES Services Element programme.
It is a consolidation action focusing on a multi-service chain dedicated to operational oceanography, that will be demonstrated in the project for two initial services: Oil spill and on Water Quality / Algae Bloom monitoring, with future extension foreseen to many other services.
These services will deliver information in real-time at ocean variability scale, i.e. hours to few days, resulting from Earth Observations, in-situ measurements, data assimilation and numerical ocean models.
They will be a key contributor to operational oceanography application field in Europe (context of EuroGOOS, GODAE, UE FP6), that should implement routine observations & robust interpretation of measurements from ocean and marine atmosphere.
The final goal of the ROSES project is to assess the overall benefits users can get from the proposed services and get support from the largest community of European users at European, National or regional level for the actual development and deployment of operational services.

SISA
Alcatel Space is strongly involved in the development of secure and affordable telecommunication solutions

dedicated to the risk management. Alcatel Space is actually managing a study for the SISA (Syndicat Intercommunal de la Siagne et de ses Affluents) based in Mandelieu in the south of France, and in charge of the flood forecasting and alert dissemination. The purpose of this study is to define solutions to improve their telecommunication and information exchange capabilities to face to flooding disaster situations particularly when terrestrial telecommunication network is out of order. Adapted solutions based on satellite technologies have been already demonstrated and should be used to collect hydro-meteo data (water level measured on the rivers), to connect actors during the crisis with collaborative working services (videoconferencing, shared applications) and to disseminate alerts using numeric radio services. The aim of the final project is to improve the existing forecasting system and to deploy operational satellite based solutions for rescue units, prefecture and municipalities

Satellites

Calipso
Calipso is a low orbit satellite dedicated to climatology (launch in 2004).
Alcatel Space is responsible for the Proteus platform which will support the payload (under US industrial responsability) composed of a lidar and an infrared camera to monitor the clouds and aerosols.
Alcatel Space is also responsible for the integration and test of the satellite **under CNES contractorship. NASA is the final customer.**
Documentation: http://www.alcatel.com/space/pdf/observation/calipsogb.pdf (274KB)

Jason 1 - Poseidon 2
Alcatel Space is the main contractor for this program, launched in collaboration with the French and American Space Agencies **CNES and NASA**. JASON-1 is the first program on the multimission PROTEUS bus, a low orbit platform developped by Alcatel Space .
Launched in December 2002, JASON-1 replaces Topex-Poseidon, a US satellite whose data have contributed to spectacular advances in Space Age oceanography. JASON-1, whose lifespan is in the order of 3 years, is the first in a series of satellites that gathers oceanographic data for over a decade.
The Radar Altimeter Poseidon 2 , provided by Alcatel Space, estimates the level of the ocean at any point with a 2 cm accuracy. This last generation altimeter is world leader in this domain. Today, the results reach an altimetry accuracy better than 1.5 cm.
Alcatel Space is working now on Poseidon 3 which will be mounted on Jason 2 satellite.
Documentation Jason 1: http://www.alcatel.com/space/pdf/observation/jasongb.pdf (243 KB)
Documentation Jason 2: http://www.alcatel.com/space/pdf/observation/jason2gb.pdf (224 KB)

Meteorology : MOP and MSG
(Launch date of MSG-1 : 2002, August 28)
Meteosat is part of the World Weather Watch together with other geostationary satellites in various orbital positions around the Earth (goes in USA and GMS in Japan) . At the head of the European industrial consortium, Alcatel Space conducts the project on the basis of requirements jointly defined by the European Space Agency and Eumetsat, the European organization for spatial meteorology.
The Meteosat programme was initiated more than twenty five years ago under the leadership of ESA with Alcatel Space as prime contractor of the satellite , which is still the case today : 7 models of the first generation have been delivered and successfully worked since the origin of the European Meteo programme. The first model of the new generation has been launched in August 2002 and the first images were delivered in November 2002 .
The second and third models of MSG are in progress in our facilities.
The high performance of the new generation is 4 times better than the other ones on the market and 10 times better than Meteosat of the first generation.
Alcatel Space is the world leader in geostationnary meteorological satellites.
Documentation: http://www.alcatel.com/space/pdf/meteo/msggb.pdf (574 KB)

Payloads

ASAR
The ASAR - Advanced Synthetic Aperture Radar - is a high performance radar imaging instrument mounted on ESA Envisat satellite which collects high resolution day and night images of the Earth in any cloud coverage and weather conditions.
These images will provide a unique source of data for monitoring the environment and understanding climatological phenomena on a planetary scale.
Envisat has been launched in February 2002 and the instrument is perfectly working.
Documentation: http://www.alcatel.com/space/pdf/observation/asar.zip (101 KB)

GOCE
Goce is a gradiometer mounted on Gravity satellite which will be launched in 2006.
This ESA programme mission is to improve the earth gravity knowledge . The payload supports accelerometers and is developped in cooperation with ONERA.

Helios II
The HR instruments of both satellites of the Helios II programme, the new generation defense and security system, are realized by Alcatel Space for the French Ministry of Defense and Alcatel Space is also responsible for producing 60% (in terms of turnover) of the satellites.
The Helios II camera works in visible and in infrared with a very high resolution.
The instrument of the first Flight Model (Helios IIa) has been delivered to Astrium in December, 2002.
Documentation: http://www.alcatel.com/space/pdf/observation/heliosgb.pdf (551 KB)

IASI (First flight model delivered on July 31, 2003)
Alcatel Space, already involved in space meteorology as prime contractor for the Meteosat satellites, has just been entrusted by the CNES (Centre National d'Etudes Spatiales) and the Eumetsat organization with developing and building three flight models for IASI instrument. The IASI (Infrared Atmospheric Sounding Interferometer) program was created for the benefit of operational meteorology and climatology. The instrument will improve from 5 to 10 days the weather forecast. Its main mission includes:

- providing atmospheric temperature and humidity profiles
- providing data on the variations in ozone and other gases
- determining the temperature in the oceans and on the Earth surface
- studying radiative cloud interactions.

IASI be will be launched aboard three Metop satellites, supplied and implemented in the context of the "Eumetsat Polar System" (EPS) program. The first of these satellites is scheduled for launching in 2005.
Documentation: http://www.alcatel.com/space/pdf/meteo/iasigb.pdf (184 KB)

MERIS
MERIS is an optical multispectral observation instrument on-board the ENVISAT Satellite. Its mission is to monitor the mineral, organic and biological elements in the oceans. Its technical definition relies on a highly innovative efficient instrument configuration. The multispectral camera is the father of the future hyperspectral instruments.
The images delivered by Meris since March 2002 are remarkable and give preciuos data to the scientific community.
Documentation: http://www.alcatel.com/space/pdf/observation/meris.zip (5.78 MB)

Sarlupe
Sarlupe is a very High Resolution Military Radar System based on 5 in-orbit Satellites for the German Ministry of Defence.
Alcatel Space is responsible for the Sensor Engineering , its assembly, integration and test and the Sensor Electronics Units.

Siral

The largest terrestrial deserts are the ones made out of ice or solid state water. The monitoring of the evolution of terrestrial ices and ice shelves from space will allow a better understanding of the complex interactive process going on between ices and earth's global climate.

Therefore, in 1999, it has been decided by ESA to start the Cryosat mission. The main component of the mission is the Cryosat satellite which is equipped of the high-performance radar altimeter SIRAL to be launched end of 2004.

This presentation offers a journey on the theme "ice and climate" and about how the CRYOSAT satellite will measure those water vastness petrified by cold.

Documentation: http://www.alcatel.com/space/pdf/observation/siralgb.pdf (268 KB)

Vegetation 2 (SPOT 5 launch date : 2002, May 5)

The CNES entrusted Alcatel Space with the contract for building the VEGETATION 2 payload. On board the French Space Agency's SPOT-5 satellite, this payload will ensure, as from 2002, the continuity of VEGETATION 1, also built by Alcatel Space as Prime Contractor and launched last spring on board the SPOT-4 Earth observation satellite.

The mission of VEGETATION payloads is to provide constant monitoring of the natural and agricultural plant cover over the entire planet.

The condition of the biosphere is an essential indicator of farming production and its quality. It is also a privileged sensitive indicator of the quality of our environment. Finally, understanding how plant life functions on the broadest level informs us of certain essential climatic parameters. VEGETATION is a simple way of collecting the data necessary to study these problems. VEGETATION 1 is already operational for all these applications.

Documentation: http://www.alcatel.com/space/pdf/observation/vegetationgb.pdf (656 KB)

Science Satellites

Alcatel Space is Prime Contractor of the major scientific programs for various domains of application :
- **infrared astronomic exploration,**
- **interplanetary probes,**
- **planets detection or**
- **earth gravity measurement**.

Alcatel Space is offering the high-tech skills to CNES, ESA, NASA and other space agencies to carry out missions which are increasingly complex and range further and further afield.
The new generation of space telescopes, scientific satellites and interplanetary spacecraft has considerably widened the scope of investigation. This is a particularly exciting and ambitious field, encompassing areas such as astronomy, planetology and many other sciences - including earth sciences. Alcatel Space has many illustrations of its expertise in these domains.

Satellites

Corot (Final contract signed on July 22, 2003)
The main scientific purpose of COROT is to study the inner structure of stars. Very accurate stellar photometric techniques will be implemented. COROT will measure the variations in light emission received from a star over a long time period (150 days without occultation by the Earth). The frequential resolution of such measurements will be on the order of 0.1 microhertz. The secondary purpose of COROT is the detection of planets gravitating around stars, by measuring fluctuation in the intensity of light.
The mission comprises an exploratory program (stellar seismology only) and a general program with stellar seismology and exoplanet detection.
The payload will be mounted on the low orbit Proteus platform, developped by Alcatel Space.
The launch is foreseen in 2004.
Documentation: http://www.alcatel.com/space/pdf/science/corot-gb.pdf (990 KB)

Herschel and Planck
Alcatel Space has been selected as Prime Contractor for ESA's Herschel and Planck space satellites. This contract, the largest so far for a space science project undertaken by ESA, has been awarded to a European industrial consortium led by Alcatel Space. The contract covers the design, development, construction, test of the two spacecraft and launch and in-orbit commissioning support. Alcatel Space is also in charge of the Planck Payload Module development and the Planck spacecraft assembly and testing.
Herschel will be the largest space telescope ever launched, with a 3.5 metre primary mirror. It will be the first space observatory covering the full far-infrared and submillimetre waveband. Its mains goal is to study how the first stars and galaxies formed and evolved. Planck will help to understand the origin and evolution of our Universe. It will analyse with the highest accuracy ever achieved the first light that filled the Universe after the Big Bang, the Cosmic Microwave Background radiation.
Documentation Herschel: http://www.alcatel.com/space/pdf/science/herschelgb.zip (5.51 MB)
Documentation Planck: http://www.alcatel.com/space/pdf/science/planckgb.pdf (5.30 MB)

Payloads

Huygens
An interplanetary probe to discover Titan
Alcatel is prime contractor of Huygens, an interplanetary probe, destined to explore Titan atmosphere, the largest of Saturn’s natural satellites. This is the first time that Europe has been engaged in an interplanetary probe mission with atmospheric entry.
Huygens has been launched in october 1997 aboard a Titan IV Centaur Rocket with Cassini, a **NASA orbiter**.

Six scientific experiments provided by European and American institutes will analyse the physical and chemical properties of Titan's atmosphere, whose characteristics present some similarities with those of the primitive stages of our own planet.

A trip of 7 years for several hours of mission

After a trip of seven years, successively employing the sling-shot effect of the gravitational forces of Venus twice), the Earth and Jupiter, Hygens will arrive near Saturn in 2004. It will be ejected from Cassini and will enter the atmosphere of Titan. After aerodynamic braking in the high atmosphere, and parachute deployment, Huygens will descend for several hours till its landing on the satellite's surface. Cassini will relay the data collected by Huygens to Earth and will remain in orbit around Saturn accomplishing its own mission.

Documentation: http://www.alcatel.com/space/pdf/science/huygensgb.pdf (591 KB)

Navigation Satellites

The Pivotal European Partner in Global Satellite Navigation Program

Alcatel Space has long-standing experience in space-based navigation systems, as prime contractor for Egnos, as supplier of navigation payloads and part of the the ground segment for the Japanese MTSAT program, and as a major player in Europe's planned Galileo program. Today, this unmatched expertise and exceptional industrial capacity make Alcatel Space the pivotal European partner in all satellite navigation programs.

Systems

Egnos
EGNOS (European Geostationary Navigation Overlay System) is a european programme destined to augment, with the aid of a dedicated ground infrastructure, the military navigation constellations GPS (USA) and GLONASS (Russian), to offer to the European civil aviation authorities the capacity of navigation with safety, integrity and very high precision. EGNOS constitutes the first step of a future European system of satellite navigation : GALILEO.
The EGNOS system consists of : Broadcasting of a GPS type signal over Europe "augmented" with information of precision and integrity of the GPS/GLONASS constellations so that all the navigation receivers computes their position in a very precise manner and without risk of error. EGNOS enters into service at the middle of 2004 and will be used for the en-route phases, and non precision approach (category 1).
EGNOS will permit civil aviation industries to keep a large part of their traditional navigation infrastructure (Beacon, etc) and permits the optimisation of air space, the time of flight, fuel costs, management of fleets and improve the overall operational safety in Europe.
EGNOS will be equally adaptable to the needs of naval and terrestrial transport.
The programme is launched in collaboration with ESA, the European Commission and Eurocontrol and with Alcatel Space as Prime Contractor under the control of ESA.
EGNOS will deliver a naviga-tion with enhanced accuracy continuity and integrity, covering the areas of Europe, Africa and a part of Russia. It will be interoperable with the equivalent systems in course of development in the USA (WAAS) and Japan (MSAS)

Latest developments:
System development is proceeding satisfactorily, with a successful critical design review in May 2002. The first actual signal will be transmitted in the middle of 2003, with acceptance testing planned for April 2004. Preparations for the operational phase are proceeding concurrently, so that the first services using the Egnos signal will be available at the same time.
A number of Egnos experiments have been carried out, including :

- On September 26-27, a Cessna operated by the Dutch NLR aerospace research agency performed the first experimental automatic approaches at Nice airport, using the Egnos system prototype.
- Tests of train position location between the Hradec Kralove and Karanice stations were carried out in the Czech Republic, with results comparable to those provided by a local differential system in conjunction with GPS.
- Experiments on positioning of ships along coasts.
- A SISNeT application was developed to transmit the Egnos signal via the Internet, to improve availability in urban zones that may cause problems for satellite coverage.
- A mobile Egnos station was installed in Dakar, Senegal to check the system's static and dynamic performance in Africa. This is a first step in the GNSS initiative to provide air navigation aid in this region.

Documentation: http://www.alcatel.com/space/pdf/navigation/egnosgb.pdf (328 KB)

Galileo : a Global Satellite Navigation Service: a European initiative
Alcatel Space, as a wholly-owned subsidiary of Alcatel, the European leader in integrated telecommunications

solutions, expects to play a major role in the Galileo concession.
Alcatel Space will also be a major player in Galileo, through its leading position in Europe's Egnos program; this will enable the early establishment of Galileo services, in preparation for the Galileo concession. Moreover, Alcatel Space brings to the table its proven skills and expertise in space-based telecom and navigation systems, to expand market opportunities and enhance user services.

"… Galileo offers an alternative which will allow Europe to attain independence in Satellite Navigation signals for civil, military or scientific applications. Europe cannot miss this opportunity …" (excerpt from Mr. Romano Prodi's speech to the European Parliament on Mars 14, 2001).
"… It has been largely shown that current satellite navigation systems do not satisfy Europe's requirements, either for multimodal transportation or in other sectors. Galileo should not be conceived solely to compete with current systems, but as a complementary and compatible component, that will also ensure Europe's own independence …"
(Loyola de Palacio, European Commission Vice-President responsible for Energy and Transport, during an international conference in Munich on April 26, 2001).
Galileo must quickly ramp up production if Europe doesn't want to miss out.
However, it faces a very complex situation:

- The American signal is free and available worldwide.
- Specific GPS features are delivered to a limited number of countries as an outstanding political instrument for the system's owners.
- Trade and mass-market civilian users require better quality of service (accuracy, availability, integrity) but what price are they willing to pay?
- Regional solutions already exist (Egnos, Waas, MSAS).
- America has ambitious new plans (GPSIII).
- Regulatory issues are a problematic (in terms of Galileo frequency allocation, for example). Alcatel Space pulled out all the stops to meet its goals at the Istanbul 2000 ITU frequency conference (WRC2000), but further steps are still needed.
- Europe's political environment is very complex.
- Hundreds of billions of euros are at stake for the European economy.
- A political decision is in sight at European Union level.
- Government funding is urgently needed for the development phase, followed by the construction and deployment of the 30-satellite constellation.

The financial arrangements behind Galileo have been investigated in detail by hundred of experts around the world through countless public and private studies, conferences, forums, etc.
Conclusions are clear and virtually unanimous :

- Private sector contributions will come gradually, whenever a financial interest can be demonstrated to potential contributors (e.g., revenues generated within 18 months after the investment).
- The investment is proportional to the prospective revenues.
- Potential user markets are enormous, and mostly involve the telecom and transport industries (automotive, aviation, railways, maritime and mobility in general).
- The public sector is and will remain for years the most influential player in Galileo, in terms of regulations (emergency calls, air traffic, safety critical needs etc.), economics (as a market enabler), political considerations, both in Europe and worldwide, ownership (of all or parts of the system), etc.
- Given this situation, plus the current uncertainty in the global telecom industry, it is clear that only the public sector is capable of taking responsibility for launching Galileo.

The European Space Agency decided to support the program in November 2001, followed in March 2002 by the European Commission.
In May 2003, an agreement has been reached among ESA member states which clears the way for the official launch of the legal entity which will have the task of coordinating ESA and EU involvement in Galileo.

Galileo - Latest developments :
The Galilei contract was awarded to Galileo Industries and Thales, and is managed by the European

Commission. It continues to address the following aspects:

- architecture of local components;
- interoperability between Galileo and other systems (GNSS, GSM/UMTS, etc.);
- coordination of frequencies used by Galileo;
- standardization and certification aspects;
- market intelligence for applications using Galileo;

definition of the legal, regulatory and governmental framework for Galileo.
ESA web pages about Galileo: http://www.esa.int/export/esaSA/GGGMX650NDC_navigation_0.html
Documentation: http://www.alcatel.com/space/pdf/navigation/galileogb.pdf (240 KB)

Euridis

The Euridis satellite navigation system developed by Alcatel Space, as Prime Contractor, provides France's initial
contribution to the EGNOS programme, the European component in the first-generation worldwide navigation satellite system (GNSS-1).
The system was ordered by CNES.
In the context of the EGNOS programme, Euridis provides users with a permanent navigation signal in addition to those supplied by the GPS (American) and GLONASS (Russian) constellations. This signal significantly increases the
availability and integrity of the user's position.
Euridis navigation service will be available in the Inmarsat 3 AOR-E satellite footprint area.
Documentation: http://www.alcatel.com/space/pdf/navigation/euridis.zip (117 KB)

Payloads

MTSAT 1R

MTSAT-1R is being built for Japan and will be the first air navigation and telecommunications space system to meet the CNS/ATM concept adopted by the International Civil Aviation Organization (ICAO) in 1991. It will be operational in 2003.

Japan is the first country to use a satellite system in order to improve the management of air traffic.

Faced with the constant growth in air transport in South-East Asia and the special geographical factors in this region, the Japanese Ministry of Transport represented by the Japanese Civil Aviation Bureau (JCAB) has opted for a full-scale implementation of the Communication, Navigation, Surveillance/Air Trafic Management (CNS/ATM) concept.

Defined by the International Civil Aviation Organization, this concept is based on the use of a satellite in order to overcome the limits imposed by traditional terrestrial navigation aids.

The Multifunctional Transport Satellite (MTSAT-1R) multi-mission space programme comprises a space segment which will eventually consist of two geostationary satellites and an earth segment.

Alcatel Space is playing a leading role in this aeronautical mission and in the production of traffic and earth control stations.

The company was selected because of its twin skills in space and aeronautical applications and it will be involved at every stage of the MTSAT system.

Aeronautical mission: communication, navigation, surveillance

MTSAT 2

Built for the same customer as MTSAT 1R , MTSAT 2, a satellite under MECO contractorship to be launched in 2004 has 2 missions :

One for Aeronautical communications and Navigation aids

One for meteorological observation

Alcatel Space is in charge of the aeronautical payload : design, development , production integration and test.

Documentation MTSAT: http://www.alcatel.com/space/pdf/navigation/mtsatgb.pdf (158 KB)

Telecommunication Satellites

Telecommunication Satellites have become a cost-effective and indispensable means of connecting people all over the world - including those who are difficult to reach through terrestrial telecommunications networks.

Alcatel, through its division Alcatel Space, is the only telecommunications company in the world to be so actively involved in satellites,
Alcatel Space has over three decades of experience on geostationary communications satellites, built for prestigious customers around the world, including the tough American market. Our satellites cover all missions and all bandwidths, to meet current and future customer requirements. In particular, we are developing solutions to meet emerging market demand for Internet and broadband (multimedia) services. Alcatel Space is also the European leader in military communications systems.

Systems

Europe*Star (In Orbit)
Europe*Star is a satellite owner-operator, offering capacity on its geostationary communications satellites. The company leases whole and fractional transponders on a full-time and occasional use basis, for use with a broad range of satellite communications services including television, Internet, telephony and corporate networking. Brought into service at the start of 2001, the innovative Europe*Star 1 satellite has five high-performance beams covering Europe, Southern Africa, the Middle East, the Indian subcontinent and South East Asia. Its Europe*Star B satellite provides additional capacity for markets in Central and Eastern Europe.
An Alcatel company, Europe*Star is headquartered in London, with regional marketing offices in Cape Town and New Delhi. Europe*Star also operates its own mission control centre in Toulouse, for tracking, telemetry & control of the satellites.
Documentation: http://www.alcatel.com/space/pdf/telecom/europestar-gb.pdf (496 KB)
www.europestar.com

Syracuse III
In November 2000, the French Ministry of Defense chose Alcatel Space as prime contractor for the SYRACUSE III military communications system. The new-generation SYRACUSE IIIA satellite will join France's fleet of Telecom 2 hybrid civil/military communications satellites. SYRACUSE III will deliver the Armed Forces in 2004 significantly higher performance, in terms of data throughput, operational flexibility and resistance to countermeasures and attack. In short, it is the perfect solution for our Allies' space-based military communications over the next decade.
The SYRACUSE military satcom system will provide telephony, telegraphy and data transmission services in either automatic or manual mode, linking home base headquarters with land, sea or air units deployed worldwide.
Documentation: http://www.alcatel.com/space/pdf/telecom/syracusegb.pdf (487 KB)

WorldSpace
WorIdSpace is the first worldwide digital radio broadcasting System to use direct satellite transmission. On the rise of the 21 st century, it is nothing less than a revolution for people in Africa, the Middle East, Asia, and Latin America... a revolution in the air waves. In 1995, the U.S. company Worldspace selected Alcatel Space to deliver the Satellite System under a turnkey contract due for completion for the first region (Africa, Middle East) by the end of 1998, for Asia mid-1999, and for Latin America mid-2000. Three very powerful geostationary satellites (AfriStar, AsiaStar, Ameristar) and their earth infrastructure enable up to 4.5 billion potential listeners to directly receive dozen of programmes with remarkably easy listening on new-generation, low-cost receivers.
Among these 3 satellites are today operational in orbit ; the third, Ameristar, has still to be launched.

The range and wealth of programming are accompanied by selectable near CD quality sound, or more suitable to spoken and multimedia services such as e-mail, text reception, and the ability to download software and other low bi-rate applications.
Documentation: http://www.alcatel.com/space/pdf/telecom/wordspace.zip (309 KB)
www.worldspace.com

Services

DAB (Digital Audio Broadcast) :

Alcatel Space, the European pioneer in the development of satellite radio systems, offers cost-effective communications solutions to deliver video, digital radio, webcasting and data directly to hundreds of fixed and mobile terminals. Over the years we have built up unrivaled experience in providing total solutions, including both space and ground segments, through endeavors such as WorldSpace and XM Satellite Radio.

Radio is entering the digital age. The world's most popular medium of communication is going full-speed ahead, and satellites are playing a major role in this evolution. Africa and Asia already receive satellite radio directly via the WorldSpace system, and it is now the turn of the Americas. Numerous projects are in the pipeline in Europe and Japan as well.

In Europe, Alcatel Space and WorldSpace are jointly leading an initiative to study **S**atellite - **D**igital **S**ound **B**roadcasting (S-DSB) in Europe. Offering seamless coverage over Europe, this system would give each user access to at least one hundred crystal-clear radio programs for mobile (vehicles), fixed and hand-portable reception. The system will efficiently provide continuous mobile reception of digital audio and multimedia programs over an entire country.

Experimental demonstration of in-car digital radio reception.

Alcatel Space, a pioneer in the development of satellite radio systems, teamed up with top-tier partners to provide an experimental demonstration of in-car reception of digital radio programs and associated data services in Paris from September 5 through October 31, 2002. Its partners in this endeavor are WorldSpace, the first worldwide operator of satellite digital radio broadcasting, TowerCast, a terrestrial operator in France, the Fraunhofer Institute for Integrated Circuits (IIS-A) and Siemens VDO Automotive, and several public and private French radio networks, including Radio France (France Info, Radio France International), Europe 1, RTL, and NRJ.

The demonstration involved an L-band hybrid digital broadcasting network, combining the West beam of WorldSpace's geostationary satellite AfriStar, with TowerCast's terrestrial repeater network in the Paris region, using a T-DAB (terrestrial digital audio broadcasting) bloc allocated by the CSA (Conseil Supérieur de l'Audiovisuel), the French regulatory authority. The combined signal from the AfriStar satellite and terrestrial repeater was received in a Citroën C8 vehicle, specially equipped with a satellite receiver supplied by Fraunhofer and Siemens VDO Automotive. The demonstration will utilize technology developed by Fraunhofer for WorldSpace, in particular for satellite time diversity and terrestrial retransmission using a modulation optimized for mobile reception.

Digital radio is front-page news these days, and discussions are underway to determine content, services, distribution and technological choices. Through this demonstration program, Alcatel Space, WorldSpace, TowerCast and their partners are testing operability and showing the potential of a hybrid satellite and terrestrial transmission system for digital radio programs and associated data.

Documentation: http://www.alcatel.com/space/pdf/telecom/dabgb.pdf (285 KB)

Alcatel Space, RELY system architect

In April 2002, an Alcatel Space-led industrial consortium won a European Union design study contract for land vehicle digital radio and navigation services via satellite. It was awarded within the scope of the 5th PCRD research & development framework program on "smart" transportation solutions.

The contract culminated some 18 months of hard work by Alcatel Space teams to develop a European platform that would integrate satellite digital radio, terrestrial cellular technology and Egnos capabilities to demonstrate real-time wireless navigation and fleet-management services. The overall system has been designated RELY.

Alcatel Space is the system architect, in charge of :

- Complete definition of services to be offered to users in cars, as well as possible services for boats, truck fleets, etc.
- System specifications, especially in terms of how to collect and process data from different satellites.
- System specifications, especially in terms of how to collect and process data from different satellites.

- Monitoring platform setup and prototyping, along with partners.

Alcatel Space brings to this project its experience on several major systems, including the WorldStar satellite radio system, and as prime contractor for development of the Egnos satellite navigation system (a European complement to GPS).
The RELY system will also make use of a terrestrial return channel, with current plans involving use of the GPRS terrestrial cellphone network. The Alcatel group offers extensive opportunities for synergy in this field.
Alcatel Space is coordinating both fellow manufacturers and research labs involved in this project, including :

- WorldSpace, the satellite digital radio operator, which offers access to the AfriStar satellite and will contribute its expertise in satellite radio and associated services (multimedia, data downloading, etc.).
- Fraunhofer, a German research lab specialized in satellite and terrestrial digital broadcast technologies, which developed the MP3 standard, for example. Fraunhofer is a major partner of both Alcatel Space and WorldSpace. It developed the basic technologies used by WorldSpace, and also made a major contribution to the technologies behind the XM Satellite Radio system, which has been very successful in the United States.
- Automobile manufacturers Volvo, Daimler-Chrysler, BMW and Opel are also part of the project. They contribute their in-depth knowledge of user needs, and also provide demonstration vehicles.
- Borg Instruments, a German company, produces a large part of the electronics for the cars. For this study, Borg will be in charge of integrating the system in the dashboard.
- Alcatel Mobicom (formerly Euteltracs) and Webraska contribute their knowledge of service requirements, the former for professionals and the latter for consumer applications.
- Intellicast is a Luxembourg-based company known for its development of "push & store" technologies for direct TV broadcast and "BtoB" type digital radio applications.

The RELY project team is based in Toulouse, and comprises about 30 people under the direction of Steven Bouchired.
This project could also be used as a springboard for Alcatel Space's ambitious proposals to be submitted to the European Commission's sixth PCRD framework research & development program, kicking off at the end of 2002.
www.rely-europe.com

Broadband services : "DSL in-the-Sky"
Alcatel Space is involved in strategic partnerships of two-way satellite based systems using broadband technology (in Ku and Ka band frequencies) based on the DVB-RCS standard and targeting the Enterprise market, professional users such as corporations and small and medium-sized companies.
In this domain, Alcatel Space, working with industrial partners which are already committed to the development of DVB-RCS subsystems, is working on the development of the systems and will supply gateway and terminal products.
In July 2003, Alcatel Space has signed two important contracts :

- One with the Nanjing Toptry China-Spacenet Co. Ltd, a broadband access service provider in Peoples' Republic of China, for the turnkey delivery of a "DSL in-the-Sky" broadband access network, including a satellite gateway, Customer Premise Equipments (CPEs) and a comprehensive network management platform.
- Alcatel Space has also signed an agreement with EMS Satellite Networks, a division of EMS Technologies, Inc. supporting the "DSL in the Sky" DVB-RCS solution proposed by Alcatel Space.This agreement expands on the DVB-RCS preliminary cooperation agreement signed in June 2002. As a result of this agreement, EMS Satellite Networks will provide Alcatel Space with its Return Link Sub-System (RLSS), and its end-user terminals. Alcatel integrates this EMS equipment into its "DSL in the Sky" solution.

Documentation: http://www.alcatel.com/space/pdf/telecom/a9780gb.pdf (1.61 MB)

AMC-9, 12 and 13 (AMC 9 Launch date : June 7, 2003)
Alcatel Space was selected by the American operator SES AMERICOM, a subsidiary of SES GLOBAL, to build 3 powerful telecommunication satellites : AMC9, AMC 12 and AMC 13.
AMC 9 is based on a SpaceBus 3000B3 Platform with 24 C-Band and 24 Ku -Band transponders ; it will be dedicated to digital TV, telecommunications, data and video transmissions for the North American market.
AMC-9 is now offering commercial services from 85° W.
AMC-12 is based on the new generation Spacebus 4000 platform with 72C-Band transponders ; it will provide digital TV, telecommunications, data and video transmissions, connecting over the Atlantic Ocean North and South America, Europe and Africa.
AMC-13 is based on the new generation Spacebus 4000 platform with 60C-Band transponders ; it will provide digital TV, telecommunications, data and video transmissions, connecting over the Pacific Ocean North America and Asia Pacific.
Documentation AMC-12: http://www.alcatel.com/space/pdf/telecom/amc12gb.pdf (217 KB)
Documentation AMC-13: http://www.alcatel.com/space/pdf/telecom/amc13gb.pdf (216 KB)

Apstar VI
Alcatel Space will supply its advanced SB4000 geo-stationary telecommunications satellite and its associated ground segment for APT's APSTAR VI project . With 50 Ku-band and C-band transponders, the satellite offers APT the capability to provide advanced broadband multimedia, new digital television services and traditional telecommunications services to telecom and television operators in the Asia Pacific region.
APT Satellite Holdings Limited (APT) is the leading satellite operator in the Asia Pacific.
The transponders are tailor-made for APT based on the latest space technology, enabling the powerful commercial satellite to have a "footprint" that extend over almost the whole Asia Pacific region from India, China to Australia ; enhancing terrestrial reception quality and reducing the size of satellite receiving dishes.
China, a promising market, is covered with a dedicated high power Ku-band beam for broadband multimedia transmission.
Documentation: http://www.alcatel.com/space/pdf/telecom/apstar6gb.pdf (216 KB)

Hot Bird™7A (Contract signed on July 28, 2003)
The order for this new satellite follows the loss of HOT BIRD™ 7 during launch last December. In addition to the original specifications, HOT BIRD™ 7A's mission has been expanded to provide additional back-up and replacement capacity at Eutelsat's key orbital slot, 13 degrees East, the world's leading neighbourhood for satellite television broadcasting. This expanded mission has led to the choice of a larger, more flexible satellite platform than for the original version.
HOT BIRD™ 7A will be based on Alcatel Space's Spacebus 3000 B3 platform. Launch is planned for the autumn of 2005, when the new satellite will join Eutelsat's HOT BIRD™ family of satellites co-located at the 13 degree East slot and reaching 100 million houses, and currently broadcasting 676 video channels and 565 audio channels. Equipped with 38 Ku-band transponders of 33 MHz minimum each (end of life), HOT BIRD™ 7A will replace HOT BIRD™1. The other 20 transponders will be available for potential back-up and replacement capacity for the HOT BIRD™ 2, 3 and 4 satellites. HOT BIRD™ 7A has a design life of 15 years. It will weigh about 4,000 kg at launch, and its solar panels will provide 10 kW of electrical power.

Koreasat 5
Alcatel Space has signed a Euro 148 million contract with KT Corporation (formerly Korea Telecom) and the Korean Agency for Defense Development (ADD) to build South Korea's first civil and military communications satellite, Koreasat 5. Alcatel Space will supply both the multimission satellite and its ground control system, along with launch and early operations phase (LEOP) support.
Based on the new-generation Spacebus 4000 platform from Alcatel Space, Koreasat 5 will feature a state-of-the-art broadband payload, including new technologies developed within the scope of the Syracuse III program. With 36 transponders in Ku-band, C-band (civil) and SHF band (military), Koreasat 5 will deliver advanced

broadband multimedia and digital television transmission services, along with conventional telecom services to operators in the Asia-Pacific region.Satellite is part of South Korea's new high-capacity spacecom system.

Rascom

Alcatel Space to supply RascomStar-QAF, the pan-African satellite service operator, with an in-orbit satellite and its associated ground infrastructure dedicated to the African continent. Under an agreement with RASCOM, the Regional African Satellite Communication Organization, representing the interests of 44 African telecommunications operators, RascomStar-QAF has the responsibility to implement by 2006 the first African satellite telecommunication system covering the whole continent. This satellite will offer RascomStar-QAF the capability to provide fixed voice, data telecommunications and Internet access as well as broadcasting satellite services to the whole African continent, although its footprint extends beyond Africa to include part of Europe and of the Middle East.

Based on the Spacebus 3000B3 platform, this high performance, high capacity satellite will provide a pan-African coverage with multiple spot beams based on 12 Ku and 8 C bands transponders. The system's ground networks will include gateway Earth stations and low-cost, solar powered rural terminals.

Star One C1

Alcatel Space has signed a 190 million US dollar contract with the Brazilian satellite operator Star One for the construction and the in-orbit delivery of the telecommunications satellite Star One C1 for Latin America.

The satellite will be launched in 2004 by an Ariane 5. It will be equipped with 44 transponders in Ku-Band to provide South America high speed Internet and multimedia capacity. It will allow the Andean Pact countries (Bolivia, Colombia, Ecuador, Peru and Venezuela) working through Andesat to develop a satellite communications infrastructure - a key to regional integration.

Alcatel Space teamed up with Andesat back in 1999 to create a joint company, Bolivar*Sat, to launch a satellite system into the 67 degrees West slot, and market its services .

In April, Alcatel Space sold its share in Bolivar*Sat to the Brazilian operator Star One, which now has 51 percent of the company, alongside Andesat. Together they will operate the Star One C1 satellite.

Satellites

Atlantic Bird™ 2 (Launch date : 2001, September 25)
Alcatel Space has built-Atlantic Bird™ 2 (26 channels in Ku Band for this Spacebus 3000 B2 Satellite) for Eutelsat, the Europe's leading satellite operator. An organisation federating 48 European countries, Eutelsat currently operates 23 in-orbit satellites. Indeed, including Atlantic Bird™ 2, Alcatel Space has manufactured 15 birds for Eutelsat : 5 Eutelsat II's, 2 Hot Birds, 4 Eutelsat W's, 1 SESAT (with NPO-PM) and 1 EUROBIRD, 2 Atlantic Bird . 14 of these satellites are now operating successfully in orbit. By meeting a rapid delivery schedule (16 month on ground delivery), which is made possible by an advanced production policy for the Spacebus 3000B platform, Alcatel Space has enabled Eutelsat to meet crucial back-up service requirements while expanding digital and multimedia services. In addition to the on-ground delivery of Atlantic Bird™ 2, Alcatel Space's prime contract with Eutelsat provides for the satellite's launch campaign, as well support for its operations and mission analysis.
The satellite is operationel in orbit since the 25th of September 2001.
Documentation: http://www.alcatel.com/space/pdf/telecom/AtlanticBird2gb.pdf (641 KB)

Atlantic Bird™3 (Launch date : 2002, July 5)
Alcatel Space is Prime Contractor for Atlantic Bird™3 (named before Stellat 5), the satellite built for the former operator Stellat now owned by Eutelsat.
The satellite is based on a Spacebus 3000 B3 platform with 35 Ku-band and 10 C-band channels.
Atlantic Bird™3 is dedicated for broadcast and IP services across 5 continents with a possibility of a two-way Internet access. Atlantic Bird™3 is a highly versatile satellite capable of adapting to market.

Eurasiasat (Launch date : 2001, January 10)
EURASIASAT S.A.M., the international satellite operator is a subsidiary of Alcatel Space owned by Turk Telecom (75%) and by Alcatel Space (25%).
To fulfil future telecommunication needs, including Direct To Home TV (analog and digital), radio services and data transmission (Internet, IBS, VSAT...), EURASIASAT has entrusted Alcatel Space with building the Eurasiasat 1 Telecommunications satellite.
The satellite is based on a Spacebus 3000 B3 platform with 32 Ku-band channels.
Its main coverage bridges Europe to Asia while 12 channels are available via 2 steerable beams with inter beam switching capability among fixed and steerable. This process provides the flexibility to target market demand in Russia , India, Africa, and in all area in satellite visibility.
Documentation: http://www.alcatel.com/space/pdf/telecom/eurasiasatgb.pdf (265 KB)
www.eurasiasat.com

EuroBird™ (Launch date : 2001, March 8)
The EUROBIRD™ satellite, built for the operator Eutelsat, provides broadcasting and telecommunication services primarily to the Western and Central European region from an orbital position of 28.5° E. Launched in the first quarter of 2001, the satellite is designed for 24-channel operation over its minimum lifetime of 12 years. The satellite provides continuity for the telecommunication services currently provided by the DFS-Kopernikus satellite, including business services, satellite news gathering and television and radio programme distribution. In addition, the high transmit power of the EUROBIRD™ satellite makes it ideal for providing broadcast programmes and multimedia services into very small and inexpensive satellite dishes. As well as a fixed beam, the satellite has two steerable beams which offer the possibility for service provision at either a national or a regional level.
Documentation: http://www.alcatel.com/space/pdf/telecom/Eurobird_gb.pdf (407 KB)

Hispasat 1D (Launch date : 2002, September 18)
Alcatel Space has built for the Spanish company HISPASAT S.A. the Hispasat 1D satellite is a powerful

telecommunication satellite based on a Spacebus 3000 B2 platform with 28 Ku-band channels ; it offers pan-European and pan-American multi-area coverage. This coverage can extend to certain areas of North Africa. The flexibility offered by the satellite's design will allow users to benefit from intercontinental links between Europe and the Americas.
Hispasat 1D provides a complete range of services : digital T.V. broadcast (including live television), telecommunications, data and video transmission and access to Internet and multi media services.
Alcatel Space was already the contractor for Hispasat 1C, in orbit since February 2000.
Documentation: http://www.alcatel.com/space/pdf/telecom/hispasat1D.pdf (235 KB)

Hot Bird™ 6 (Launch date : 2002, August 21)
In October 1999, Eutelsat ordered from Alcatel Space the latest and most powerful satellite in the HOT BIRD™ series. The HOT BIRD™ 6 satellite provides a total of 32 active transponders. Twenty-eight of these operate in the Ku-band. The remaining four transponders operate in the Ka-band. The twenty-eight Ku-band transponders are connected to a high-power Super-Widebeam coverage to facilitate the provision of television broadcast and multimedia services over the entire European continent, North Africa and the Middle East. The in-orbit redundancy of the HOT BIRD™ satellite system is enhanced through the provision of back-up capacity on HOT BIRD™ 6 for all of the HOT BIRD™ 5 channels and for a set of HOT BIRD™ 4 channels. The satellite also provides additional Ku-band capacity to be leased at 13 degrees East. Additionally, services that are currently broadcast by HOT BIRD™ 5 can be upgraded to take advantage of the HOT BIRD™ 6 satellite's very wide coverage area. The satellite's advanced Ka-band payload design enables the organization to address several additional markets from high-end Internet users, small- and medium-sized businesses, and SOHOs (Small Office Home Office workers) within a Western European coverage area. The unique combination of the Ka-band and SKYPLEX provides further opportunities for new multimedia service development, where access via very small transmit/receive user terminals (for example, micro-TV, IP-Broadcasting and interactive network applications).
Documentation: http://www.alcatel.com/space/pdf/telecom/hotbird6.pdf (346 KB)

W 5
The W5 satellite is the 15th satellite delivered by Alcatel Space to Eutelsat.
Positioned at 70.5 degrees East, it offers a complete range of services, including video distribution and contribution links, occasional use video, especially for satellite newsgathering (SNG), and Internet backbone connections.
Built on the Spacebus 3000 platform, it is equipped with 24 Ku-band transponders, configured with one fixed widebeam covering Western Europe, central Asia and the Indian subcontinent, and two steerable spotbeams. The spotbeams can be steered according to commercial requirements to cover all accessible zones, especially Southeast Asia.
Weighing over 3,000 kg at liftoff, the satellite develops 6 kW of power and has a design life exceeding 12 years.

Astra 1K
In December 1997, the Luxembourg-based Société Européenne de Satellites (SES) entrusted Alcatel Space with realizing the largest most versatile telecommunications satellite ever built, with 52 Ku-band channels and 2 Ka-band channels . The mass at launch was 5.25 T and the power 15 Kwatts.
SES GLOBAL, the leading provider of satellite capacity for DTH broadcasting, owns and operates ASTRA, a system of 8 satellites with an audience of nearly 91.3 million households in 30 European countries.SES is also the main share holder in ASIASAT, the leading satellite operator in Asia. Overall, the zones receiving ASTRA and ASIASAT cover three quarters of the world population.
To reinforce the fleet currently in orbit, Alcatel Space had to provide the direct television and multimedia satellite ASTRA 1K for SES.
Unfortunately, the ILS launcher Proton did not succeed to reach the geostationnary orbit and the satellite had to be de-orbited on Dec 10 th 2002.
Documentation: http://www.alcatel.com/space/pdf/telecom/astra1kgb.pdf (200 KB)

Stentor

The Stentor technological satellite was a French experimental programme to validate, in flight, advanced technologies which would be integrated in the next generation of telecommunications spacecrafts.

The aim of this program was to bring French competence to the highest level, both for the prime contractors and the equipment manufacturers, and the ultimate was to improve France's competitive position on the export market. It was supported by CNES (French Space Agency), France Telecom (French Telecommunications Operator) and DGA (Ministry of Defence).

Its development was under responsibility of a two co-prime contractors which shared the developments :

Alcatel Space for the Spacebus 3000 platform (structure, thermal control, solar array, harness, deployable radiator, chemical and plasmic propulsion). Alcatel Space was also responsible for the communication payload (active antenna, on-board processor, repeater using intermediate frequency conversion) and TCR (Telemetry, Command and Ranging) Subsystem, and for all Assembly, Integration and Validation activities.

Astrium for Eurostar 3000 avionics (data handling, electrical power conditioning, attitude and orbit control.

Unfortunatly, this satellite has been pulled down during the failure of Ariane 5 10T launcher on December the 11th 2002.

Documentation: http://www.alcatel.com/space/pdf/telecom/stentorgb.pdf (391 KB)

Payloads

DFH4
Alcatel has signed in September 2002 a contract with the China Academy of Space Technology (CAST) for the development and construction of a new telecommunications satellite. This partnership will allow both contractors to develop the first high capacity Chinese telecommunications satellite.
Alcatel will provide the payload module to CAST for the integration of the first China made high capacity communication platform DFH4 into a complete satellite. The new satellite that will be delivered to APT (Hongkong), is tailored to provide communication, radio and TV broadcasting services to telecom operators and to radio and TV stations. The satellite is to be launched by China Long March launcher in 2005.

NOTA :China's Sinosat1 satellite, which has been operating well for many years, was provided by Alcatel.

Express A2 and A3
Alcatel Space has realized the telecommunications payload for the Express A1 satellite, the first in a series of three satellites, which contributes to the renewal of Russia's satellite fleet. The payloads for these three satellites, designed and manufactured by Alcatel Space at the Company's Toulouse facility, were integrated on the satellite platform for NPO-PM (prime contractor) at Krasnoyarsk (Siberia). Express A2 and Express A3 (launch failure for Express A1) have been put into service by the Russian national telecommunications operator RSCC and deliver global communications, data and television services.
The satellites resulting from this partnership were designed to distribute throughout the territory direct television programs that can be received using small individual satellite dishes.

Express A1 R AM11 AM22
Alcatel Space built the communications payload for Express A1-R satellite, and is realizing the 2 other payloads of Express AM11 and Express AM22. The Express satellite fleet provides coverage of Western Europe, Russia, the Middle East and Asia dedicated to telecommunications services.
Alcatel Space will participate to the satellite tests at NPO-PM in Russia, and also to the launch campaign in Kazakhstan.
Documentation AM22: http://www.alcatel.com/space/pdf/telecom/am22gb.pdf (261 KB)

Globalstar
Globalstar is a worldwide mobile telephone network using satellites, a constellation of low earth orbit satellites connected with the ground cellular networks by more than a hundred connection stations throughout the world.
Alcatel Space has provided 64 payloads to fulfill the mission.
Documentation: http://www.alcatel.com/space/pdf/telecom/globalstar.zip (223 KB)

Intelsat IX (In Orbit - Last Launch on February 15, 2003)
INTELSAT IX telecommunications satellites, also called INTELSAT FOS-II, replace the INTELSAT VI satellites which were launched from 1989 onwards and are still in service for INTELSAT Ltd., the International Satellite Telecommunications Organization.
Created in 1964, Intelsat Ltd. is the oldest and second largest international satellite telecommunications organization. This company formed in connection with the privatization of the former intergovernmental organization INTELSAT on July 18, 2001, is privately owned by an international group of over 200 shareholders; major owners include Lockheed Martin Corporation (beneficial owner), Videsh Sanchar Nigam Limited, France Telecom, Telenor Broadband Services A.S., and British Telecommunications plc.
It provides in most areas of the world, telecommunications services through its worldwide network: telephony, fax, television programme broadcasting and data transmission.
Successive generations of INTELSAT satellites have made it possible to cope with the rapid growth of international traffic generated by companies and individuals by using the very latest technologies.

The contract signed for the Intelsat IX satellite payloads in March 1997 was awarded jointly to Alcatel Space and Space Systems/Loral.
Alcatel Space was responsible for manufacturing the repeaters which account for roughly 35% of the value of the contract, and for the test support during satellite integration at SS/L in Palo Alto .
The repeaters, like those on INTELSAT VI satellites, allow an operating mode that is adapted to high bit-rate digital links. A dynamic switching matrix increases their interconnection capacity.
Documentation: http://www.alcatel.com/space/pdf/telecom/intelsatgb.pdf (737 KB)

Sesat
In addition to the three Express A satellites, Sesat has been manufactured in cooperation with NPO-PM for the Eutelsat organization.This satellite offers several types of services, including data & video brodcasting, Iinternet back-bone connections, distance learning, telemedecine, transfer of software.
The coverage includes Europe, Western Siberia, North Africa, and the Middle East.
Documentation: http://www.alcatel.com/space/pdf/telecom/sesat.zip (98 KB)

XM Radio : 3 flight models delivered to Boeing Satellites System and a contract for a 4th payload won in September 11, 2003
Satellite Radio provides nationwide mobile digital audio broadcasting (DAB) via satellite in the U.S. XM Radio listeners will receive quality services with up to 100 radio stations coast-to-coast in both urban and rural areas. To accomplish this, XM Satellite Radio uses 2 high-power Hughes 702 telecommunications buses supplied by Hughes Space and Communications Company (now BOEING Space Systems), in partnership with Alcatel Space, which was in charge of payload development.
It has radically changed the face of audio broadcasting, with an ever-larger choice of digital quality programs coast-to-coast. The powerful telecommunications satellites guarantee optimal signals and system reliability for XM Radio. Imagine driving from New York to Los Angeles without ever losing your favorite XM radio station : more choice, more freedom, more variety and higher quality ! As many as 100 stations will be broadcast simultaneously and continuously, regardless of your movements.
The system is available in cars sold in the United States.
Alcatel Space was responsible for the design, production, integration and test of the 3 powerful repeaters developed for the XM Radio satellites.
3 satellites have been built : "Rock" and "Roll", in orbit and 1 ground spare.
The excellence performance of this geostationary satellite based system will bolster Alcatel Space approach to deploy digital satellite broadcasting in Europe.
Documentation: http://www.alcatel.com/space/pdf/telecom/xmradiogb.pdf (227 KB)

EXHIBIT 3

List of Technical Documents

Exhibit 3 – List of Technical Data

This table summarizes the information covered in the International Agreement
between NASA and Alcatel.
Listed in this table are the only portions ANALEX, and America Intellicom, Inc. (aka AISolutions) have potential to export.

Technical Data description
Mission Integration Working Group (MIWG), Ground Operations Working Group (GOWG) and Launch Operations Working Group (LOWG) will be conducted in accordance with the Medium Expendable Launch Vehicle Services (MELVS) . Discussion will involve the following
• Spacecraft to Launcher Interface Control Documents (ICD)
• Spacecraft/launch vehicle technical interface issues
• Technical splinters will be held as a part of the meetings on an “as required” basis
• Technical Interchange Meetings (TIMs) will be held as required on specific technical subjects/problems
• Telecons on specific topics also will be held as required
NASA/CNES Reviews & Launch Site Activities
• Flight Readiness Review
• Launch Readiness Review
• Launch Management Coordination Meeting
• Mission Dress Rehearsal
Payload processing, launch vehicle integration, and test
• Payload Requirements Document (PRD)
• Launch Site Support Plan (LSSP)
• Launch Site Test Plan
• Launch Site Procedures
• Combined System Test
Review/Comment on the following spacecraft deliverables
• P/L Launch Site Test Procedures, Final (S/C Stand Alone & Integrated S/C-L/V)
• Final Launch Window Constraints
• P/L Launch Checklist / Mission Constraints
• P/L Dress Rehearsal Requirements
Review/Comment on the following NASA deliverables
• Post-Launch State Vector
• Coupled Loads Analysis – Preliminary
• Coupled Loads Analysis – Final
• Preliminary Mission Analysis
• Final Mission Analysis
• RF link and compatibility
• Post Launch Quick Look Analysis
• FRR & LRR High Level Minutes

EXHIBIT 4

Technology Transfer Control Plan (TTCP)

Technology Transfer Control Plan
To accompany the
Technical Assistance Agreement
Between
Analex Corporation (U.S.) and Alcatel (France)
for the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)

General: This Technology Transfer Control Plan (TTCP) is intended to supply guidance and direction to employees of Analex Corporation (Analex) and its subcontractors (if any) for protecting United States technology from inadvertent and illegal transfer to foreign nationals employed by any of the parties to the subject Technical Assistance Agreement (TAA) or any other agreement concerning CALIPSO. To be effective, a TTCP must identify what technology may be transferred or co-developed through discussion, display, or by physical means such as paper, e-mail, or Internet. It must identify to whom such transfers may be made and it must prescribe means to report the transfers and any violations of the terms of the TAA. Lastly, it must provide a means to both train employees and record that training.

Background: The National Aeronautics and Space Administration (NASA) has negotiated a formal Memorandum of Understanding or MOU with the Centre National d'Etudes Spatiale (CNES) that has the former agree to use its launch services contract to launch the cooperatively-built CALIPSO; to support its operations once on orbit, checked out, and functioning; and to share the Earth science data that CALIPSO will produce. The MOU calls for the signatories' centers and contractors to produce a detailed breakout of the tasks and responsibilities of the parties called the CALIPSO Project Plan that shall be empowered by the MOU and have the force of an international agreement.

Alcatel will provide the PROTEUS spacecraft bus, and performs payload-to-spacecraft integration of the Imaging Infrared Radiometer (IIR) instrument, plus the other two instruments (Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) and Wide-Field Camera (WFC) both provided by NASA, who purchased them from Ball Aerospace) a portion of which occurs at the launch site (Vandenberg Air Force Base (VAFB), Lompoc, CA), under NASA supervision.

NASA has contracted with Analex to provide the on-site payload-to-launch vehicle integration services under the ELVIS contract with NASA's Kennedy Space Center (which operates NASA's facilities at Vandenberg AFB, California.). Analex will perform a safety and mission assurance oversight role, launch site support engineering role, a launch operations management role, a mission integration coordination role, a communication and telemetry support role, to provide technical services to the NASA/Analex Launch Engineering Team (LET), provide on-site technical, security, and administrative support and assist in the technical preparation of the spacecraft at Vandenberg AFB, California, provide mission analysis of the following analytical areas: Loads and Structural Dynamics, Dynamic Environments, Stress, Flight Design, Flight Software, Controls and Stability, Thermal/Thermodynamics, Electromagnetic Compatibility & CFD/Aerodynamics, and perform engineering and analyses for the NASA Program, which necessitates this agreement.

Analex personnel will perform the work from Kennedy Space Center (KSC), and on site at Vandenberg AFB (VAFB), California to get the launch vehicle and CALIPSO payload integrated and ready for launch, and will assist with other tasks required of it by the CALIPSO Project Plan and the ELVIS contract Statement of Work or SOW.

What may be Transferred: The TAA authorizes Analex to carry out the tasks described in the CALIPSO Project Plan and the ELVIS SOW and to permit Alcatel employees to have access to the technical documents described in the TAA. Thus, ANNEXES B and C and Exhibit 2 of the TAA, as allowed in the final State Department license; i.e., the TAA in the form and with the provisos returned to Analex by the Office of Defense Trade Controls, describe the techniques, know-how, and technical data that are permitted to be shared.

Training: All Analex employees working on CALIPSO are required to have completed Kennedy Space Center (KSC) web based training lessons: "Basic Export Control Program," "Foreign National Visit Processing," and Technical Information Exchange." These lessons are provided in CD-ROM format for those who do not have access to the internal KSC website or the NASA SOLAR website. All Analex employees working CALIPSO will read the CALIPSO Project Plan and the ELVIS SOW. These establish the procedures they are to follow and the limits to their cooperative work with Alcatel employees.

All training will be recorded by the Analex Program Manager (PM.)

Operations: From the first moment that Analex and Alcatel personnel start work until the final moment of such cooperation, Analex personnel will observe the limits to cooperation that the TAA permits. Logs or other records of topics discussed, documents accessed, issues resolved, and other cooperative work will be kept up to date and will be accessible to employees, managers, and NASA alike. Where the topics discussed and the work done are clearly within the framework of the TAA, these records need not be elaborate or detailed. Where there is any question of whether or not the material worked with falls within the bounds of the TAA, then detailed records of what was discussed, with whom, when, and where must be made. Such records must also be available as before, but it is the responsibility of the senior employee involved to make the Analex PM aware of the matter as soon as possible. If at any time any Analex employee is uneasy about what is being done or discussed, it is perfectly appropriate for the employee to terminate the activity at once and report it to the Analex PM or such person as the Analex PM has designated to receive these reports.

Physical security will be provided by NASA and Analex in accordance with the procedures specified by the Commander, 30th Space Wing, USAF. These procedures are stringent and call for 100% escort for all foreign nationals while on Vandenberg AFB. Compliance with these procedures supports this TTCP.

NASA has published its direction, procedures, and guidelines in NASA Program Directive (NPD) 1371.5, Coordination and Authorization of Access by Foreign Nationals and Foreign Representatives to NASA and NASA Program Guidance 1371.2, Coordination and Authorization of Access by Foreign Nationals and Foreign Representatives to NASA, use of

which is mandated by the ELVIS contract. NASA has also implemented an automated visit control system, the NASA Foreign National Management System (NFNMS). NASA's processes for handling foreign nationals call for checks of various U.S. Government agency lists to determine if individuals have been listed as barred from doing business with the Government or are otherwise to be carefully watched. NASA visit processes will be used to manage visits by Alcatel personnel to Vandenberg and to meetings, etc., held on the subject of CALIPSO. Compliance with these procedures supports this TTCP.

KSC Procedures for foreign national access to KSC and CCAFS are contained in Kennedy Handbook (KHB) 1610.1, KSC Security Handbook, Section 406. These call for a Technology Transfer Risk Assessment (TTRA) for visitors from certain countries and for any visitor who will be on station more than a total of 30 days in one year. This procedure is specifically extended for Alcatel personnel working at Vandenberg for more than 30 days in one year. Compliance with these procedures supports this TTCP.

Recording: All records, logs, notes, etc., that result from the operation of this TTCP will be maintained under the control of Analex' Empowered Official for five (5) full years after the expiration date of the Technical Assistance Agreement; i.e., five years from December 31, 2007.